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PHYSICS AND MATHEMATICS

No. 59

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USSR REPORT

PHYSICS AND MATHEMATICS

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This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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NUCLEAR PHYSICS

FUTURE WORK ON DEVELOPMENT OF THERMONUCLEAR ENERGY

Moscow IZVESTIYA in Russian 11 Oct 79 p 2

[Article by A. Ivakhnov, Special Correspondent of IZVESTIYA: "Future Energy is Being Born: At the Institute of Atomic Energy imeni I. V. Kurchatov Yet Another Step Has been Made on the Path Toward Synthesizing Controlled Thermonuclear Fusion"]

> [Text] Scientists hope that within the next five years it will be possible to achieve controlled thermonuclear fusion at the Soviet Angara-5 facility. That facility will consist of 48 modules--giant electron "guns" aimed at a walnut-sized target. Inside the target is a mixture of nuclei of the isotopes of hydrogen--deuterium and tritium. All the "guns" will fire simultaneously. The combined power of the 48 electron beams will surpass the combined power of all the electric power stations in the Soviet Union. Within a few billionths of a second the target will be heated to hundreds of millions of degrees Centigrade. This is sufficient to assure the fusion of the nuclei. The released energy should exceed the energy expended on initiating the thermonuclear fusion.

A prototype of such a module, the Angara-1, was developed and built at the Institute of Atomic Energy imeni I. V. Kurchatov five years ago. It consists of an energy accumulator--a pulsed-voltage generator--on whose 20 "floors" are installed parallel-connected industrial capacitors, and an election accelerator which externally resembles several different-sized cylinders lying on their sides and overlapping each other; the initial cylinder is man-sized, while the final one, from where the electron beam emerges, could surely be encircled with one's hands. The entire facility occupies a single room--a large one, to be sure. I was shown metal plates in which holes were drilled by the electron beam. In experiments with the Angara-1 experts learned to control that beam and determine its parameters.

This year, in accordance with one of the tasks of a complex program which is among the 200 programs for the solution of the principal scientific and techni-

cal problems of the 10th Five-Year Plan period, it was decided to accomplish the physical start-up of the first experimental module of the Angara-5 facility. The crews participating in the fulfillment of this task adopted socialist labor competition pledges to carry it out ahead of schedule. And so now the module is ready for operation. In principle it resembles the electron accelerator of the Angara-1 facility, but it differs in power and dimensions, occupying a large hall consisting of several multi-meter bays. From the second-floor balcony extending alongside that hall the accelerator has a particularly impressive appearance, somehow resembling the Salyut-6 orbital station, except that it is even larger. To facilitate the assembling and operation of the facility, each subunit of the accelerator rests on a trolley and all the trolleys stand on tracks. The control panel of an Angara-5 module alone occupies about as much room as the whole Angara-1. One can visualize the size of the entire facility (whose mockup, incidentally, is now being displayed in the Physics Pavillion of the USSR All-Union Exposition of Achievements of the National Economy, where 48 such machines will be aligned fanwise in two stages around a reactor within which thermonuclear microexplosions will reverberate....

On the eve of the physical start-up of the module, correspondents of central newspapers and TASS met with the Deputy Director of the Institute of Atomic Energy imeni I. V. Kurchatov. Corresponding Member of the USSR Academy of Sciences Valeriy Alekseyevich Legasov.

The scientist declared: "First of all, I would like to discuss energy problems and how we look at them.

"In the history of mankind the traditional sources of energy have been supplanted with newer and better sources several times. And all this happened not because the old source was exhausted. Once man had no other source of heat and light than the Sun, and no one had ever conceived the idea that that luminary may extinguish itself some day, but nevertheless man learned how to use fire and began to burn wood. At the same time, a qualitative change took place in the development of civilization: fire can be used to cook food, and as a result men's habitations became warm. Subsequently, firewood gave place to black coal. Not because the timber resources became depleted, but because the new fuel was needed for steam machinery. Some time had passed, and black coal gave up its leadership on the energy market to petroleum. That was another advance in the development of civilization: aircraft and automobiles made their appearance, ships changed completely, and industry began to develop more actively. And yet the earth's reserves of petroleum are about only one-tenth as large as its reserves of black coal. Clearly, the point is not the total reserves of one energy source or another, but the cost effectiveness of its extraction and transportation to users as well as the convenience of its use. And the replacement of energy sources cannot be compared to, say, burning a new pile of logs after the previous pile had been burned. The question must be viewed much more broadly--this concerns the natural process of the growth of civilization.

"And so at present we happen to be living during a period of transition to yet another energy source. These days the leading types of fuel are petroleum and

gas. But the extraction of every additional cubic meter of gas or every additional ton of crude requires a continually greater northward or eastward development of deposits and a continually deeper advance into the depths of the earth, and hence petroleum and gas will cost us more and more with each year.

"With what, then, can the existing energy sources be replaced? At present the pretenders to leadership in this plane are nuclear sources. The reserves of uranium are small--fewer than a ten-thousandth fraction of the reserves of coal. But per unit weight they contain a million times as much energy as does coal. Hence, the generation of the same amount of energy at atomic power stations requires only one-hundredth as much labor and resources than does the extraction of energy from coal. This accounts for the superiority of nuclear sources.

"One more important factor is that, inasmuch as the fission of uranium nuclei entails the formation of radioactive fragments, the atomic "furnace" itself should be of an extremely hermetically sealed design so as to prevent the escape of these products in anyway whatsoever. And once such hermeticity has become technically feasible, we have an energy source which does not cause environmental pollution. That is another reason why many countries are now converting to nuclear fuel.

"But the reserves of uranium are not limitless. Moreover, reactors at present do not use all of uranium but only its one isotope--uranium-235, of which not more than one percent is contained in the overall mass of that element. There are two paths along which the search for new energy sources can proceed. One path is the development of atomic power stations which could burn not just one uranium isotope but all uranium. The other path is the attempt to achieve not the fission energy of heavy uranium nuclei but the fusion energy of light nuclei of hydrogen isotopes--deuterium and tritium. Deuterium is present on earth in extreme abundance--it is contained in seawater and its extraction is not very expensive, and there is no need to search for its deposits, since it is always at hand.

"The attainment of a controlled thermonuclear reaction requires the satisfaction of two conditions: First, a temperature of roughly 100 million degrees Centigrade must be attained; And second, the product of the nuclear concentration density and the time interval of that temperature should exceed a specified quantity. That is, either a fairly rarefied gas is heated within, say, one second--which to physicists is a long interval of time--or a dense blob of deuterium and tritium, a tablet, gets heated within billionths of a second. The tokamak-type facilities will operate in accordance with the former principle, and the Angara-type facilities, in accordance with the latter.

"The heating of nuclei to such gigantic temperatures can be achieved in two ways: with the aid of laser radiation, or with the aid of charged-particle beams. The Angara-type installations will use the latter. From the engineering standpoint, this type of heating seems to us more simple and reliable. All the 48 modules of the thermonuclear facility are identical, and if the first of these, whose start-up we are now readying, yields its share of energy, this

means that we are on the right road and that the Angara-5 facility can be adapted to the conditions required for controlled thermonuclear reactions. The operation of the future industrial thermonuclear facilities can be visualized as a sequence of explosions of deuterium-tritium tablets, each yielding its share of energy--and taken together, these "portions" will coalesce into a continuous energy flux. But that, of course, is not a matter of the immediate future. For the time being we are just readying the physical start-up of the first module of the facility in order to check its performance quality. After all, a controlled thermonuclear reaction is an extraordinarily complex thing and has to be approached without haste, step by step...."

Further, Valeriy Alekseyevich pointed out that the personnel of many institutes and enterprises took part in the development and construction of the experimental module. The principle equipment of the module was designed and built at the Scientific Research Institute of Electrophysical Apparatus imeni D. V. Yefremov and at the Dvigatel' Engine Plant. The complex automation system indispensable to the operation of the facility was developed by experts from the All-Union Scientific Research Institute of Instrument-Making. Now that the module is ready, it can be proudly stated that our science and industry have coped with their task.

Scientists, engineers, and workers participating in the development of the thermonuclear module have fulfilled their pledge. The physical start-up of the innovation took place on schedule. At the Institute's meeting devoted to the start-up, the President of the USSR Academy of Science Academician A. Aleksandrov delivered an address. He declared that the start-up of the first module of the Angara-5 is a major step forward on the path toward mastery of truly inexhaustible energy sources.
[44-1386]

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ACOUSTIC CHARACTERISTICS OF LASER BREAKDOWN IN TRANSPARENT DIELECTRICS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1730-1734
manuscript received 12 Dec 78

ASHMARIN, I. I., BYKOVSKIY, Yu. A., GRIDIN, V. A., ZYSIN, Ya. Yu., IVANOV, A. Yu., YUDIN, S. I., Moscow Engineering Physics Institute

[Abstract] An investigation is made of a pressure wave propagating through a material from a laser breakdown focus in a transparent dielectric. It is shown that the wave structure at great distances from a source is determined by the conditions of its formation and is associated with the energy characteristics of the source and the properties of the material, and that the investigation of this structure may yield information on the source of the wave. An experimental study is done on the space-time structure of a compression wave as a function of the distance from the source of laser breakdown and the energy of the initiating emission. Theoretical and experimental results are compared and shown to agree qualitatively and quantitatively. The authors thank A. S. Aleksandrov for constructive criticism. Figures 5, references 6: 4 Russian, 2 Western.
[24-6610]

INFLUENCE OF SURFACE WAVES ON REFLECTION OF SOUND FROM A ROUGH SURFACE

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 77 No 3(9), Sep 79 pp 1175-1182 manuscript received 12 Apr 79

URAZAKOV, Ye. I. and FAL'KOVSKIY, L. A., USSR Academy of Sciences Institute of Theoretical Physics imeni L. D. Landau

[Abstract] An experimental curve taken from an earlier study (1966) is shown, illustrating the dependence of the coefficient of reflection of ultrasound incident from a liquid onto the surface of a solid, on the angle of incidence, where the angle of reflection is equal to the angle of incidence. In the region of total reflection, when body sound waves cannot be propagated in the solid, a minimum exists whose position and form depend on the properties of the surface. This fact is of interest from the practical viewpoint, in particular, as one method of nondestructive testing. The origin of the minimum observed is associated with the excitation in the solid of surface waves. These waves are similar to Rayleigh waves propagated along the surface of a solid bounded by a vacuum. When the solid is bounded by a liquid the surface waves are attenuated because of radiation into the liquid. In spite of this radiation, for an ideally

flat surface the reflection coefficient must become unity in the same region in which the excitation of surface waves is possible. Detailed consideration is given here to the reflection of sound incident from a liquid onto the rough surface of an isotropic solid. It is found that with angles of incidence consistent with total internal reflection the reflection coefficient has a distinct minimum caused by the excitation of surface waves. This minimum is extreme in the case of roughness which is minor as compared with the sound's wavelength and of mild roughness. The reason for this is competition between roughness and the low ratio of the acoustic impedance of the liquid and solid. The position and form of the minimum are studied in relation to the frequency of the sound and roughness parameters. The assumption is made that the surface studied is flat on average, and that the mean level of irregularities is low as compared with the normal component of the sound's wavelength (relative to the surface) and as compared with the distance along the surface, on which the roughness varies considerably. These conditions make it possible to expand the boundary conditions in a series in terms of the surface's deviation from an ideally flat one, as is usually done in the familiar method of minor perturbations. By this method it is possible to study the influence of the roughness on the passing wave in a similar manner to how the reflection coefficient is considered. Figures 2; references 7: 5 Russian, 2 Western.
[31-8831]

USSR UDC 621.315.592

EFFECT OF ELECTRON BOMBARDMENT ON THE ELECTROPHYSICAL PROPERTIES OF GERMANIUM-SILICON SOLID SOLUTIONS

Baku DOKLADY AKADEMII NAUK AZERBAYDZHANSKOY SSR in Russian Vol 35, No 4, 1979 pp 29-31 manuscript received 25 Dec 78

BAKIROV, M. Ya., ABIYEV, A. K., ABBASOV, Sh. M. and GASUMOV, G. M., Radiation Research Sector, Academy of Sciences of the Azerbaijanian SSR

[Abstract] An experimental study was made of the effect of electron bombardment on the continuous system of p-type solid solutions over the 0-15 atom.% Si range. Specimens of single crystals with 0, 8.10 and 15 atom.% Si respectively were grown by the Czochralski method, their initial hole concentration ranging from $1.5 \cdot 10^{14}$ to $1.97 \cdot 10^{15}$ cm^{-3}. Their electrical conductivity and Hall coefficient were measured at temperatures from 77 to 500 K before and immediately after bombardment with 3.5 MeV electrons, also after subsequent annealing at 420 K. According to the data, electron bombardment increases the Hall mobility and lowers the hole concentration so that a reversal to n-type conduction occurs at some temperature which becomes higher with increasing silicon content. An anomalous behavior of some specimens with a lower silicon content after annealing may be due to a nonuniform distribution of silicon atoms or due to establishment of a radiation level within the forbidden band. The results indicate the feasibility of controlling the properties of germanium-silicon alloys by varying the dose of electron bombardment. The article was presented by academician (Academy of Sciences of the Azerbaijanian SSR) L. M. IMANOV. Figures 2; references 6: 5 Russian, 1 Western.
[55-2415]

USSR UDC 539.2

CONCERNING A POSSIBLE CAUSE FOR INCREASED SOLUBILITY IN SMALL PARTICLES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 6, 1979 pp 1376-1380 manuscript received 4 Jun 79

MOROKHOV, I. D., CHIZHIK, S. P., GLADKIKH, N. T., GRIGOR'YEV, L. K. and STEPANOVE, S. V., Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] The phase composition, substructure and physicochemical properties are different in massive and fine specimens of the same metals at the same temperatures. The increased solubility in small particles and condensed films is attributed chiefly to the particulars of producing

such highly dispersed systems, for example intense supercooling and supersaturation in the case of condensed films, i. e. the effect is explained mainly by kinetic parameters. However, the particulars of condensation alone cannot explain the observed solubility of components or the dependence of solubility on islet size or film thickness. Observed differences in the behavior of small particles as compared with massive specimens can be explained in an uncontradictory way if one accounts for the difference in the equilibrium concentration of vacancies in specimens of small dimensions as compared with a bulk specimen, leading to a vacancy mechanism of the size effect. It is shown that the concentration of vacancies is higher in small particles than in massive specimens, and that this concentration increases with a reduction in particle size. Thus the solubility increase can be explained by the fact that vacancies capture atoms of the dissolved substance. Figures 2, references 14: 12 Russian, 2 Western.
[20-6610]

USSR UDC 541.44

PHASE TRANSFORMATIONS IN THE Tc-H SYSTEM AT HIGH PRESSURE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 6, 1979 pp 1420-1423 manuscript received 30 Mar 79

SPITSYN, V. I., Academician, PONYATOVSKIY, Ye. G., ANTONOV, V. Ye., BELASH, I. T., and BALAKHOVSKIY, O. A., Institute of Solid State Physics, Academy of Sciences USSR, Chernogolovka, Moskovskaya Oblast, Institute of Physical Chemistry, Academy of Sciences USSR, Moscow

[Abstract] An investigation is made of the solubility of hydrogen in technetium at 300°C and $P_H \leq 19$ kbar, the thermal stability and structure at P = 1 atm of Tc-H solutions produced at high pressure, and the behavior of isotherms of the electrical resistance of technetium at $T \leq 350^\circ C$ and P_{H_2} of the order of 15 kbar or less. Specimens were made from ^{99}Tc foil 0.05 mm thick. Temperature measurements were accurate within 5°C, and pressure measurements--within 5 kbar. The Tc-H specimens for chemical and x-ray analysis were made by holding the foil at 300°C at the given hydrogen pressure for 5 hours. The chamber then was cooled to 0°C, pressure was reduced to atmospheric level, and the foil was removed from the chamber. The accuracy of determining the ratio n of hydrogen/metal was 0.05. For specimens saturated at a hydrogen pressure of 19 kbar, $n = 0.73 \pm 0.05$. Kinetic curves for a constant heating rate of 3°C/min show that the liberation of hydrogen becomes noticeable beginning at about 80°C, and at 300°C the dissociation of the hydride is practically complete. The kinetics of hydrogen release remains sluggish up to about 200°C. Dissociation of technetium hydride takes several months at room temperature and atmospheric pressure. Powder patterns showed that $TcH_{0.73}$ in a single-phase compound with hcp lattice. The lattice parameters are given for this

hydride, and also for hydrides of manganese and chromium, which also form interstitial phases with hcp lattice with hydrogen. Technetium hydride seeme to be an analog of manganese hydride in both structure and thermal stability. Both these hydrides show a noticeable and nearly identical reduction in the ratio c/a with an increase of hydrogen concentration, whereas solutions of Co-H show almost no change in c/a with concentration. The authors thank K. A. Peresad and A. N. Grachev for constant assistance in preparing and doing the experiments. Figures 4, references 10: 6 Russian, 1 Polish, 3 Western.
[20-6610]

USSR UDC 539.1.03

RESONANT ACCELERATION OF CHANNELED PARTICLES IN THE FIELD OF A STRONG LIGHT WAVE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249, No 1, Nov-Dec 79 pp 100-102 manuscript received 9 Jul 79

BELOSHITSKIY, V. V. and KUMAKHOV, M. A., Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov

[Abstract] The channeling effect offers an excellent method of controlling the trajectory of charged particles during their acceleration in a laser field. Here dechanneling of a particle due to multiple scattering and the effect of this on the acceleration process are analyzed on the basis of energy relations. Necessary electric field intensities and maximum attainable acceleration energies are established for positive particles, taking into account also the fragility of crystals. Considered is, furthermore, acceleration of relativistic particles due to resonant absorption of light according to the reverse Cerenkov effect. In strong accelerating fields (over 1 GV/cm) diffusion from a channel is found to be suppressed by a decrease of the emittance so that a thick crystal can be used. In the case of particles with low energies (under 0.1 MeV/nucleon) transverse motion is impeded by friction against electrons so that in an electric field of corresponding adequate intensity a beam can be collimated without an increase of energy. The article was presented by academician Ye. P. BELIKHOV on 18 May 79. References 5: 3 Russian, 2 Western.
[56-2415]

USSR UDC 548.736

CRYSTALLINE STRUCTURE OF POTASSIUM-ZINC-BERYLLIUM SILICATE $K_2Zn_2Be_2(SiO_4)(Si_2O_7)$

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249, No 1, Nov-Dec 79 pp 103-105 manuscript received 6 Jul 79

BALKO, V. P., BAKAKIN, V. V., GATILOV, Yu. V. and PAVLYUCHENKO, V. S., Institute of Inorganic Chemistry, Siberian Division of the USSR Academy of Sciences, Novosibirsk

[Abstract] The crystalline substance $K_2Zn_2Be_2(SiO_4)(Si_2O_7)$ was produced at the Institute of Geology and Geophysics (Siberian Division of the USSR Academy of Sciences) by a hydrothermal reaction in the K_2O-BeO-ZnO-SiO_2-H_2O system. The specimen examined at the Institute of Inorganic Chemistry was faintly pink in color and 0.2x0.1x0.1mm^3 in size, with a rhombic crystal cell of the Imam group and an experimentally determined density of 3.23 g/cm^3 . Its structure was further examined with a Syntex-$P2_1$ diffractometer using MoK_α radiation and by standrad scanning. Data taken from sufficiently intensive 1616 out of 2192 total reflections were processed according to the MULTAN-XTL program with the optimum estimators. The structure has been found to be polyhedral, featuring not only the already well known silicioxyl biradical but also two kinds of cations (beryllium and zinc) in the tetrahedral envelope, with short contacts through a common oxygen bridge, as well as separate Be_2O_6 diortho-groups and Zn_2O_6 diortho-groups condensed into a $(Zn_4O_8)_\infty$ ribbon. The article was presented by academician N. V. BELOV on 6 Jul 79. Figures 2; tables 2; references 12: 5 Russian, 7 Western.
[56-2415]

HOT LUMINESCENCE IN GALLIUM SELENIDE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21 No 8, Aug 79 pp 2217-2222 manuscript received 8 Jan 79, after correction 20 Mar 79

BAGAYEV, V. S., BELEN'KIY, G. L., ZAYTSEV, V. V., SALAYEV, E. Yu. and STOPACHINSKIY, V. B., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev

[Abstract] Processes are discussed which result in hot luminescence from excited states of direct free excitons in layered single crystals of gallium selenide. The results are discussed of experiments relating to a study of the low-temperature luminescence spectra of layered single crystals of gallium selenide in which in addition to radiation from the ground state of an excited exciton are observed lines corresponding to

excited 2s, 3s and 4s states. Samples of GaSe grown by the Bridgman technique in the epsilon modification, primarily, were investigated. Measurements were made with the steady-state excitation of an He-Cd laser with a wavelength of 4416 Å and a power of approximately 10 mW at a temperature of 2 K. The signal was recorded photoelectrically, employing an FEU-79 photomultiplier, a PAR model 126 lock-in amplifier (a narrowband amplifier with a synchronous detector) and a KSP-4 recorder. The maximum excitation density was not higher than 1 kW/cm^2. Graphs are shown of radiation spectra which show lines characteristic of 2s, 3s and 4s excitons. Also plotted is the dependence of the energy position of the ground and excited states of a direct exciton on $1/n^2$, where n is the principal quantum number. The intensity of photon $\hbar\omega_2$ is approximately two orders of magnitude less than that of $\hbar\omega_1$. The ratio of the intensities of the radiation line of an exciton in the 1s and 2s states indicates the distinctly nonequilibrium nature of radiation from excited states, for with a temperature of 2 K the population of levels with $n > 2$ is negligibly low. This fact makes it necessary to consider radiation from excited states to be related to hot luminescence. Features of the band structure of GaSe are discussed, whereby it is demonstrated that at low temperatures all radiation of GaSe must be regarded as hot luminescence. This is obvious from comparing the typical radiation spectrum with the energy position of exciton states. The band structure suggested makes it possible to explain all experimental data on the kinetics of the photoluminescence of GaSe. Various mechanisms are discussed which can be responsible for the luminescence of free excitions from excited states of a direct excition, where n = 2, 3 and 4, with an optical excitation density of $I \gtrsim 1$ W/cm^2. It is demonstrated that the hot luminescence observed is evidently associated with the scattering of free excitons by defects in the crystal lattice. When the excitation density is increased above 100 W/cm^2, another mechanism becomes probable. This mechanism is explained in terms of the features of the band structure of gallium selenide. The resonant nature of exciton states at the center and at the edge of the Brillouin zone is considered responsible for this mechnnism. Indirect excitons having an energy somewhat less than that of direct excitons, of approximately 4 meV, as the result of inelastic collisions can be thrown into possible states of a direct exciton. With an optical excitation density of about 100 W/cm^2 inelastic collisions of indirect excitions from different valleys become probable, as the result of which one of the excitons is thrown into the n = 1, n = 2, ..., states of a direct exciton, and another decays radiatively, imparting an energy equal to the difference in the energies of the first exciton in the final and initial states. This second mechanism can be assisted by the first, for interaction with defects or impurities can be responsible for an increase in the probability of intervalley relaxation. The first mechanism proposes that in a crystal with a great number of defects the de-excitation of excitons from excited states is caused by the scattering of excitons by defects, which results in the flopover of free excitons into the photon branch. The two mechanisms suggested do not contradict one another. Figures 4; references 18: 6 Russian, 12 Western. [29-8831]

OSCILLATIONS OF THE RESONANCE COMBINATION LIGHT SCATTERING CROSS SECTION IN THE LONGWAVE REGION OF THE SPECTRUM IN POLAR SEMICONDUCTROS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21 No 8, Aug 79 pp 2430-2534
manuscript received 3 Apr 79

BELITSKIY, V. I. and GOL'TSEV A. V., USSR Academy of Sciences Physico-Technical Institute imeni A. F. Ioffe, Leningrad

[Abstract] A new kind of resonance Raman light scattering has been hypothesized in polar semiconductors--electron-phonon Raman scattering--which is related to many-phonon cascade processes and originates as a result of the following sequence: Primary radiation with a frequency of ω_l produces an electron-hole pair; the electron (or hole) can successively radiate several longitudinal optical (LO) phonons, and then emit without annihilation with a hole (or electron) a quantum of secondary light with the simultaneous radiation or absorption of the LO phonon. The electron-phonon Raman scattering (EPRS) cross section is of a zero order in relation to the Fröhlich constant for the coupling of electrons or holes with LO phonons and has characteristic threshold features in relation to the frequency of the primary light, ω_l, and secondary emission, ω_s. Unlike earlier studies, this paper takes into account the interaction of electrons and holes with acoustic phonons, as well as with LO phonons. This has resulted in a new phenomenon, viz., the origin of strong oscillations of the scattering cross section as a function of the frequency of the primary light, ω_l, in the region of secondary emission frequencies of $\omega_s < \omega_{LO}$, where $_{LO}$ is the frequency of an LO phonon. A straight-band isotropic polar semiconductor is discussed and it is assumed that the interaction of electrons or holes with LO phonons is much stronger than interaction with acoustic phonons. The origin of oscillations of the EPRS cross section in polar semiconductors is considered for the case when the Frohlich constant equals $\alpha << 1$. The discussion is limited to a specific temperature range of $2v_0\sqrt{2m_e\hbar\omega_{LO}} << k_BT << \hbar\omega_{LO}$, where v_0 is the speed of sound in the crystal and m_e is the mass of an electron. The origin of strong oscillations remains valid even with $\alpha \simeq 1$. A necessary condition is the triviality of the dispersion of LO phonons and a cascade process for the movement of electrons or holes through the band. The mechanism for the origin of oscillations is similar to the mechanism for the origin of oscillations of photocurrent in these semiconductors when the frequency of the primary light is increased. Figures 2; references 5: 4 Russian, 1 Western.
[29-8831]

USSR UDC 621.373.5

GAIN OF ELECTROMAGNETIC RADIATION OF A SEMICONDUCTOR PLACED IN A MAGNETIC FIELD AND IN THE FIELD OF AN ULTRASONIC WAVE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1786-1789
manuscript received 31 Aug 78

ALEKSANYAN, A. G., BOYAKHCHYAN, G. P. and MIRZABEKYAN, E. G., Institute of Radio Physics and Electronics, Academy of Sciences, Armenian SSR, Ashtarak

[Abstract] The gain of an electromagnetic wave is calculated in a semiconductor located in a magnetic field and in the field of an ultrasonic wave. It is shown that a gain of 1-500 can be achieved over a wide range of variations in parameters. Analytic expressions are derived for the way that the real part of the radio-frequency conduction depends on frequency for various pumping powers, ultrasonic wavelengths and temperatures of the specimen. The authors thank B. M. Gyurdzhyan for assistance in doing the computer calculations, and also I. A. Poluektov for useful discussions of the results. Figures 3, references 4 Russian.
[24-6610]

USSR UDC 548:539.21

GROWTH AND OPTICAL PROPERTIES OF MERCURY THIOGALLATE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1807-1809
manuscript received 24 Jan 79

BADIKOV, V. V., MATVEYEV, I. N., PANYUTIN, V. L., PSHENICHNIKOV, S. M., REPYAKHOVA, T. M., RYCHIK, O. V., ROZENSON, A. E., TROTSENKO, N. K. and USTINOV, N. D.

[Abstract] An investigation is made of the HgS-$HgGa_2S_4$ phase diagram. It is shown that there is a region of solid solutions based on $HgGa_2S_4$. Optically homogeneous single crystals of mercury thiogallate are grown and used for measuring indices of refraction in the 0.55-11 μm band. A phase synchronism diagram is constructed for a frequency mixing process of the type $o + o \rightarrow e$ that shows the presence of synchronous interaction in the given wavelength band. The results show that such single crystals should be useful as an effective nonlinear material. Figures 4, references 3: 1 Russian, 2 Western.
[24-6610]

SPATIAL MODULATION OF LIGHT IN A PHOTOSENSITIVE STRUCTURE MADE UP OF A LIQUID CRYSTAL AND AN INSULATED GALLIUM ARSENIDE CRYSTAL

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1810-1812
31 Jan 79

KOMPANETS, I. N., PARFENOV, A. V. and POPOV, Yu. M., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] The paper gives the results of an experimental study of photosensitive MDS structures in contact with a nematic liquid crystal. When gallium arsenide is used as the semiconductor and the orientational electro-optical effect in the liquid crystal is utilized, high energy sensitivity of the structure can be realized. The minimum level of helium-neon laser emission intensity on 633 nm that is needed for 180° phase modulation of light or for maximum optical contrast of the order of 100:1 was $5 \cdot 10^{-7}$ W/cm^2 at a switching energy of 10^{-8}-10^{-9} J/cm^2. Spatial resolution was at least 10-12 lines per millimeter. This structure can be used for input and conversion of optical information, including for visualizing infrared emission. The authors thank L. M. Blinov and V. V. Titov for furnishing the liquid crystals and for constructive criticism, A. A. Vasil'yev and P. D. Berezin for consultation in doing the experiments. Figures 3, references 5: 4 Russian, 1 Western. [24-6610]

CYCLOTRON FREQUENCY SHIFT FOR ELECTRONS LOCALIZED ON THE SURFACE OF LIQUID HELIUM

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 77 No 2, Aug 79 pp 717-732 manuscript received 21 Mar 79

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[Abstract] A discussion is given of the possible reasons for the effect of the reduction in the cyclotron mass of surface electrons as a function of the strength of an external pressure-exerting electric field revealed in a previous detailed study of the phenomenon of cyclotron resonance in the case of free electrons localized on the surface of liquid helium. In the case of surface electrons localized in the vapor-liquid plane, this type of localization always occurs with a growth in the pressure-exerting field and a lowering of temperature and the surface of helium at the point of electron localization is self-consistently deformed. In turn, the deformation of the surface which originates acts as a potential well for the localized electron. The process of the localization of surface electrons is facilitated considerably by the inclusion of a strong magnetic field

normal to the surface of the helium. The effect of a perpendicular electric field on a charged spot on the surface of helium of finite dimensions will automatically result in deformation of the surface. The reduction in the effective mass of an electron in a quantizing magnetic field under the effect of a pressure-exerting electric field is shown to be consistent with the phenomenon of self-consistent deformation of the surface of helium under the effect of a localized electron. An analytical solution is given to the problem of the influence of self-consistent deformation of the surface of helium on the value of the cyclotron frequency of surface electrons in the presence of a strong magnetic field. It is demonstrated that for electrons localized on the surface of liquid helium the shift in the cyclotron resonance frequency has a twofold origin: 1) a dynamic shift resulting from the interaction of electrons with thermal vibrations of the helium's surface, and 2) a static shift resulting from self-consistent deformation of the surface of the helium under a localized electron exerting pressures on the free surface of helium, and the counter influence of this deformation on the electron's motion. The question is discussed of the relative role of both these shifts in the case of low density of surface electrons. Static renormalization of the cyclotron frequency of surface electrons plays the key role under conditions of slight heating of the electron system and fairly low temperatures. The shift in the cyclotron resonance frequency is of static origin if $T \ll \hbar\omega_H$, where ω_H is the cyclotron frequency, over the entire range of pressure-exerting fields. In an intermediate temperature range of $T \lesssim \hbar\omega_H$ the dynamic shift begins to compete with the static shift and even proves to be preferred. The concept of the characteristic density of surface electrons is introduced, which has a considerable influence on the amount of the static shift. At this density, electron-electron interaction exerts a considerable influence on the r.m.s. displacement of electrons from the position of equilibrium. The results of the theory presented describe correctly from a qualitative standpoint the experimental data available for the cyclotron resonance frequency shift for the conditions given here over a wide range of electron density and of the pressure-exerting field, but not without certain inconsistencies. The need for further study is stressed. References 15: 11 Russia., 4 Western.
[30-8831]

KINETICS OF THE DISINTEGRATION OF METASTABLE POLARIZED CRYSTALS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 77 No 3(9), Sep 79 pp 1093-1106 manuscript received 26 Mar 79

KAGAN, Yu., SMIRNOV, B. M. and SHLYAPNIKOV, G. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Metastable polarized crystals are crystals made up of atoms with parallel electron spins. A demonstration is given of the fact that the disintegration of a crystal of this type is associated chiefly with the origin of distinctive spin waves called magnons, which carry negative energy. A theoretical description is given of the key channels for the disintegration of metastable polarized crystals, and it is demonstrated that these channels can be suppressed by employing an external magnetic field opposite to the direction of polarization of electron magnetic moments. Dipole-dipole interaction between electron spins results in the decay of the polarized state into one magnon and two phonons, and a second-order process caused by simultaneous hyperfine interaction and magnon-phonon interaction of an exchange nature results in the decay of the polarized state into one magnon and one phonon. Disintegration channels of this type are not suppressed by a magnetic field. These two channels are discussed individually. Discussed in detail are local spin flip, spin waves in metastable polarized crystals, and the decay of a crystal by means of the excitation of spin waves, in terms of single-magnon and two-magnon excitation and decay via the excitation of magnons and phonons. The application of an external magnetic field as described above makes it possible to suppress generally single-magnon and two-magnon decay without the excitation of phonons or with the excitation of a single phonon on account of dipole-dipole interaction. In the case of polarized crystals of alkali atoms the first of the decay channels mentioned which cannot be suppressed by a magnetic field results in a probability of decay per particle of approximately 10^{-3} to 10^{-4} s^{-1}, which represents a fairly long lifetime. The second channel represents a relatively faster process, with a probability of decay in the range of approximately 10^{-1} to 10^{-3} s^{-1}. The extent of this probability varies substantially from element to element and from isotope to isotope. This decay channel can also be suppressed with the simultaneous polarization of nuclear spins. Figures 1; references 4: 2 Russian, 2 Western.
[31-8831]

USSR UDC 533.27

INVESTIGATION OF THE INTERACTION OF A HYPERSONIC AIRFLOW WITH A CARBON DIOXIDE AEROSOL

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ALFEROV, V. I., BIRYUKOV, A. S., BOZHKOVA, Ye. A., DMITRIYEV, L. M., MARCHENKO, V. M. and PROKHOROV, A. M., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] In this paper an examination is made of gasdynamic processes that take place when heterogeneous flows interact with consideration of phase transitions, and it is shown that emission is amplified when a CO_2 aerosol is mixed with a hypersonic airflow. Analysis shows that the vaporizing aerosol mixes with the vibrationally excited gas in times that are shorter than the relaxation time of the upper lasing level. For flat flow geometry with symmetric input of the aerosol, the transverse size of the active medium may reach 20 cm or more when the height of the critical cross section of the hypersonic nozzle is of the order of 1 mm. Conditions are found under which there are no gasdynamic perturbations in the mixing zone and the active medium is optically homogeneous. A CO_2 aerosol generator is developed with a distribution function of solid particles by sizes that is close to optimum. Experiments on flow interaction are done on a facility with a conical hypersonic nozzle for air with perpendicular aerosol inlet. General agreement is observed between the experimental results and the theoretical predictions. Amplification of CO_2 laser radiation close to the calculated value is observed in the region of mixing of the excited air with the CO_2 aerosol. Figures 6, references 9: 6 Russian, 3 Western.
[24-6610]

USSR

UDC 533.6+535.21

EXPANSION OF THE PLASMA LAYER NEAR A LASER-IRRADIATED OBSTACLE IN HIGH-DENSITY GASES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 6, 1979 pp 1368-1371
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NEMCHINOV, I. V., PETRUKHIN, A. I., PLESHANOV, Yu. Ye. and RYBAKOV, V. A., Institute of Physics of the Earth imeni O. Yu. Shmidt, Academy of Sciences USSR, Moscow

[Abstract] Previous research has dealt with the onset and evolution of a plasma cloud close to an obstable surrounded by high-density gases under the action of neodynium laser emission with duration of τ = 1 ms and spot diameter of d = 1 mm. Under such conditions, because of lateral spreading of the plasma, the pressure in it is close to the initial pressure of the gas medium, and the rate of expansion of the plasma boundaries is only a few meters per second. As τ decreases and d increases, the process of plasma development will take place under different conditions. In this paper, the authors report on experiments done with a neodymium laser with energy E = 80 J emitting a smooth bell-shaped pulse with duration of $\tau_{1/2}$ = 0.5 μs incident on a flat obstable. The laser spot had sharp edges, and within the limits of its diameter of d = 8 mm the uniformity of irradiation was no worse than 10-15%. Any time pulsations in the density of the laser flux were shorter than 1-3 ns. The obstacle was placed in a chamber filled with high-density gases. It was found that high density retards dispersal of the laser plasma. The hot gas behind the plasma front expands like a flat layer, generating a plane shock wave in the gas. Curves are given showing the time dependence of brightness temperature for variation emitted by the plasma in opposition to the laser beam, and also for pressure on the obstacle, and for the height of the shock wave and plasma front. Two pressure peaks are observed on these time curves: the first is associated with completion of the mode of vaporization and onset of the plasma that shields the obstacle from the direct action of laser exposure. This peak corresponds to sharply rising brightness temperature. The second peak is associated with a transition to the mode of "expulsion" in which the mechanical efficiency is rather high despite shielding because considerable amounts of dense gas surrounding the target are put into motion. The use of different gases produces results that are similar qualitatively though differing in magnitude. Turbulization or perturbation of the plasma front, at least far from the light detonation threshold, does not have a strong effect on parameters as calculated by the laminar theory.
The authors thank Ye. A. Berchanko, A. P. Sobolev and B. T. Fedushin for their report on the hypothesis of turbulent light combustion before publication. Figures 3, references 8 Russian.
[20-6610]

USSR UDC 621.375.826

THEORETICAL STUDY OF THE DYNAMICS OF STIMULATED EMISSION AND THE CHARACTERISTICS OF A PULSED CO LASER WITH SELECTION OF LINES SUITABLE FOR LASER ENRICHMENT OF ISOTOPES

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manuscript received 4 Oct 78

KONEV, Yu. B., KOCHETOV, I. V. and PEVGOV, V. G., Institute of High Temperatures, Academy of Sciences USSR, Moscow

[Abstract] The practical feasibility of a CO laser for isotope enrichment is limited by the efficiency, power and duration of the emission pulse. Lasing with line selection must be used in photochemistry, and pulses with a duration of several microseconds are necessary for many practical applications. A theoretical study is done on the characteristics of a CO laser pumped with pulses of about 1 μs duration, and with selection of lines that are suitable for laser enrichment of isotopes, such as $P_9(16)$, $P_9(19)$, $P_{10}(9)$ and $P_{10}(12)$. A numerical solution is found for the system of kinetic equations for populations of levels of molecules of carbon monoxide, and unsteady equations of balance for emission intensities on vibrational-rotational transitions of carbon monoxide, as well as the equation for gas temperature. It was found that when a CO laser is pumped by short pulses, with selection of lines in the bands $P_9(J)$ and $P_{10}(J)$, emission pulses can be obtained with a duration of several microseconds, but the gas temperature must be low, about 50-80 K, and an energy density of 0.05-0.1 J/cm^3 is necessary at a pressure of 100 mm Hg and a temperature of 80 K (mixture CO:Ar = 1:10). The efficiency with consideration of losses in line selection should not exceed a few percent. Figures 6, references 7: 4 Russian, 3 Western.
[24-6610]

USSR UDC 621.378.325

STATISTICAL PROPERTIES AND STABILIZATION OF A PICOSECOND LASER ON PHOSPHATE GLASS WITH RECURRENCE RATE OF 2 Hz

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1610-1619
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DIKCHYUS, G., ZHILINSKAS, E., PISKARSKAS, A. and SIRUKAYTIS, V., Vil'nyus State University imeni V. Kapuskas

[Abstract] Research is done to develop a picosecond phosphate glass laser with passive mode locking that compines high reproducibility and stability of emission characteristics with a recurrence rate between 0.5 and 2 Hz. Particular attention is given to development of a picosecond measurement complex for measuring the statistical parameters of the laser.

The measuring equipment is based on a nonlinear-optics correlator of amplitude analyzers with direct computer input. Reproducibility of ultrashort pulse lasing of better than 0.95 is achieved by optimizing saturation of gain and enhancement of transmission properties of the two-component lasing medium. The pumping energy of the laser is reduced to 260 J, and the coefficient of energy variation of the picosecond pulses is reduced to 0.08. The average duration of pulses in a train is 8.5 ps. Pulses with duration of 2.6 ps were obtained by induced Raman scattering. The duration of an isolated pulse selected from the beginning of a lasing train is 6.2 ps. The spectral Q (the product of the width of the spectrum multiplied by the duration of a pulse selected from the beginning of a train) is 0.5 in this situation, which shows absence of phase modulation. The high stability of the laser makes it suitable for using the second harmonic to pump a parametric light emitter on a crystal of α-HIO . The arrangement gives an energy conversion of up to 10% with spectral Q of 0.7.
The authors thank S. A. Akhmanov for support and constructive criticism.
Figures 7, references 20: 13 Russian, 7 Western.
[24-6610]

USSR UDC 621.373.826.038.825

THEORY OF A CHEMICAL LASER ON ELECTRONIC PHOTOTRANSITIONS WITH THERMAL INITIATION BEHIND A SHOCK WAVE FRONT

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manuscript received 19 Oct 78

IZMAYLOV, I. A., KOCHELAP, V. A., KUKIBNYY, Yu. A. (deceased) and PEKAR, S. I., Institute of Semiconductors, Academy of Sciences UkrSSR, Kiev

[Abstract] The authors work out a theory of steady-state lasers that operate at a gas pressure of 1 atmosphere or more where the time for a thermal chemical reaction is no more than 1 μs, and the reaction zone in the stream is no larger than 1 mm. The reaction must not have time to take place over a comparatively long time of mixing and feeding the mixture to the cavity. To accomplish this, the temperature of the mixture in the gas supply line must be so low that no reaction will take place. The reaction must be stimulated inside the optical cavity itself in times of much less than 1 μs. This can be done by a sharp increase in the gas temperature (by thousands of degrees in 0.1 ns) at the shock wave front set up inside the resonator. Only reactions of radiative recombination of atoms and radicals are considered here. Radicals react rapidly even at low temperatures, and therefore cannot be present in the supply line. These radicals must be produced rapidly and in large quantities inside the optical cavity, for example by thermal dissociation of stable molecules behind the shock wave front. A theory of shock waves and one-dimensional steady-state gasdynamic flow is developed with consideration of the kinetics of chemical reactions in the gas. The inverse population behind the

shock wave front is calculated for the case of reactions of photorecombination. It is proved that a waveguide arises that localizes the working mode of the laser in the inversion zone. The amplification factor of light α on the waveguide modes is calculated. The light-stimulated chemical reaction that changes the spatial dependences of density, temperature, flowrate and reagent concentrations is taken into consideration in the lasing mode in gasdynamic and chemical kinetics. The specific luminous power taken off from the flow is determined as a function of luminous losses. An examination is made of a number of specific gas mixtures, and the three most promising ones are selected for use in lasers: NO_2Cl-Ar, O_3-Ar and O_3-CO. It is shown that for these mixtures inversion arises over a wide range of wavelengths and that the conditions of waveguide arisal are compatible with the condition of formation of inversion. For these mixtures, the amplification factor of light is about 10^{-3} cm^{-1}, and the power is about 100 kW per cm^2 of the gas flow. Figures 6, references 32: 20 Russian, 12 Western.
[24-6610]

USSR UDC 621.373.8

ANISOTROPY OF INELASTIC SCATTERING AND SELECTIVE DIFFUSION OF COMPONENTS IN A GAS MIXTURE UNDER THE ACTION OF LASER EMISSION

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KALYAZIN, A. L. and SAZONOV, V. N., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] Recent experiments have shown nonthermal and selective action of laser emission on gases. Selectivity with respect to isotopic composition has been demonstrated in radiative dissociation of monatomic molecules. The emission intensity in these experiments was 10^7-10^9 W/cm^2. Selectivity with respect to chemical composition has been studied, and nonthermal dissociation of one of the components has been observed in the collisional mode. In these experiments, the intensity of resonant laser emission was relatively low (16-400 W/cm^2). In this study the authors show that selective diffusion (i. e. spatial separation of the components of the mixture in the collisional mode that takes place only with laser excitation of one of the components of the mixture) is possible at even lower emission intensities. A theoretical analysis is made of selective diffusion in a mixture that consists of light particles (molecules or atoms) that are resonantly stimulated by laser emission, and heavy particles that do not interact with radiation. In particular, it is shown that the concentration of light particles can be noticeably changed to a distance of 30 cm by infrared laser emission with intensity of only 5 W/cm^2 in a mixture with pressure of 1 mm Hg at a temperature of 500 K. This effect

is unrelated to either luminous pressure or thermal diffusion. The authors thank G. A. Askar'yan, N. V. Karlov, Yu. N. Petrov, A. N. Orlov and other participants in A. M. Prokhorov's seminar for discussing the work. Figures 2, references 14: 6 Russian, 8 Western.
[24-6610]

USSR UDC 621.373.826.038

KINETICS OF XeF EXCIMER GAS-DISCHARGE LASER

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MKRTCHYAN, M. M. and PLATONENKO, V. T., Moscow State University imeni M. V. Lomonosov

[Abstract] Previous theoretical research on the kinetics of excimer gas discharge lasers has been mainly qualitative. In particular, as yet no kinetic model has been proposed that accounts for the most complete set of possible processes and that explains the experimentally observed dependences of emission output energy on the total pressure of the mixture and the percent concentration of its individual components. The authors attempt to solve this problem on the basis of a proposed kinetic model for a laser based on a mixture of He-X-NF_3 (X = Ar, Kr, Xe) excited in a short electric discharge. The proposed model with the use of relations for the kinetic coefficients as functions of E/p and p gives a basically correct description of the dynamics of the active medium in such a laser and can be used to predict the optimum values of experimentally important parameters such as the pressure of the mixture, pulse duration and so on. The model also enables evaluation of the concentrations of excited excimers attainable under pulse discharge conditions. The kinetic scheme considered in this paper is applicable to He-Kr-NF_3 and He-Ar-NF_3. Figures 4, references 22: 3 Russian, 19 Western.
[24-6610]

USSR UDC 621.373.826.038.824

EFFECT OF DYE LASER LINEWIDTH ON THE DEGREE OF CONVERSION OF EMISSION TO DIFFERENCE-FREQUENCY LASING

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[Article translated from English by A. S. Semenov]

[Abstract] The paper gives the results of an investigation of the influence that the linewidth of dye laser emission has on the degree of conversion of emission power to difference-frequency lasing. Of particular interest is the feasibility of difference-frequency lasing over a wide frequency band. The analysis is done for pumping emission on various wavelengths. To get maximum efficiency it is necessary to reduce the dye laser linewidth. The longer the difference-frequency lasing wave, the narrower the bandwidth should be. Experiments are done in which dye laser radiation on 590 nm with linewidth varying from 0.15 to 6.5 nm is converted to difference-frequency lasing with pumping by a nitrogen laser and KDP crystal 3 cm long. The maximum degree of conversion is $3 \cdot 10^{-4}$. The authors thank Professor Hertz for furnishing the dye laser, Doctor S. Mori for constructive criticism, and Doctor Beck-Ross for furnishing a thin-layer Fabry-Perto interferometer. Figures 5, references 9: 1 Russian, 8 Western.
[24-6610]

USSR UDC 621.375.826

ON THE ULTIMATE LENGTH OF LASERS USING COMPLEX ORGANIC COMPOUNDS WHEN LASING IS REABSORBED BY UNEXCITED AND EXCITED SINGLET MOLECULES

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1655-1665
manuscript received 20 Nov 78

STOYLOV, Yu. Yu., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] An examination is made of the mechanism of limitation of stimulated emission power in lasers based on complex organic compounds with consideration of the influence of reabsorption of stimulated emission by unexcited and excited singlet molecules. It is shown that reabsorption leads to limitation of the laser emission power. The efficiencies of stimulated emission of lasers and amplifiers are compared. Formulas

are derived for evaluating the ultimate length of amplifiers and lasers. Dimensionless parameters are found that define the feasibility of scaling laser systems based on complex organic molecules. Examples are given of calculation of the emission parameters of lasers based on POPOP vapor and on a solution of rhodamine 6G. The author thanks K. K. Trusov for constructive criticism. Figures 4, references 9: 4 Russian, 5 Western.
[24-6610]

USSR UDC 621.375.9:535

INCREASING THE EMISSION BRIGHTNESS OF A POWERFUL Nd^{3+} PHOSPHATE GLASS LASER BY SPATIAL FILTERING OF THE BEAM IN AN AMPLIFICATION CHANNEL

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1666-1671
manuscript received 9 Nov 78

ALEKSEYEV, V. N., STARIKOV, A. D., CHARUKHCHEV, A. V. and CHERNOV, V. N.

[Abstract] An experimental investigation was made of the influence that small-scale self focusing has on the output brightness of the beam of the amplifier channel of neodymium glass lasers. Sources of regular perturbations of the spatial profile of the amplified beam were eliminated by using an apodizing aperture and an optical relay. Spatial filtering of the amplified beam was used to suppress irregular perturbations. It is shown that the brightness of the output beam can be considerably heightened by appropriate selection of the parameters of the vacuum spatial filter. A beam 40 mm in diameter is produced with peak intensity of 2.4 GW/cm^2; small-scale focusing did not cause any noticeable energy losses in an angle fo 0.25 mrad. The authors discuss the feasibility of using criteria of evaluation of the influence that small-scale self focusing has on the brightness of the amplified beam in developing amplification channels with periodic spatial filtration. The authors thank A. A. Mak for support of the work and constructive criticism, V. A. Teslenko for assistance in analysis of the results and manufacture of the apodizing apertures, and N. M. Vasilenko for assistance with the computer calculations. Figures 5, references 12: 7 Russian, 5 Western.
[24-6610]

USSR UDC 621.373.826.038.823

NONRECIPROCAL EFFECTS IN A RING LASER WHEN A TRANSVERSE MAGNETIC FIELD IS APPLIED TO AN ACTIVE MEDIUM

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ANDRONOVA, I. A., KUVATOVE, Ye. A. and MAMAYEV, Yu. A., Institute of Applied Physics, Academy of Sciences USSR, Gor'kiy

[Abstract] Nonreciprocal amplitude and frequency effects are calculated in a helium-neon ring laser when a transverse magnetic field is applied to the active medium. This is a problem of interest for physics and laser gyroscopy in evaluating the corrections to laser gyroscope readings that are associated with transverse magnetic fields. In addition, it is shown that the study of such nonreciprocal effects may be useful in nonlinear laser spectroscopy for measuring the constants of relaxation of working levels. An examination is made of the case of polarizations of opposed waves that are close to linear. It is shown that these effects are a manifestation of nonlinear polarization nonreciprocal properties that arise in the active medium when the transverse magnetic field is applied. The effects depend on the square of the magnetic field and its orientation relative to the electric field of the wave. Numerical estimates are made of possible errors of laser gyroscopes that are associated with transverse magnetic fields. The authors thank I. L. Bershteyn for a number of useful comments in examination of the manuscript. Figures 2, references 11: 5 Russian, 6 Western.
[24-6610]

USSR UDC 621.373.8.537.533

OPTIMIZATION OF THE PARAMETERS OF ELECTRON BEAMS AND SELECTION OF FOIL IN AN ELECTRON-BEAM-CONTROLLED LASER

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DUTOV, A. I., MINAYEV, S. V. and NIKOLAYEV, V. B.

[Abstract] An investigation was made of the transmission of electrons with energy of 100-250 keV through a foil-gas-anode system in an electron-beam-controlled laser, and an estimate was made of the homogeneity of ionization of the working substance over the height of the discharge gap. An examination is made of the influence that the beam parameters, composition of the active medium and the electric field in a semi-self-maintained discharge, as well as the design peculiarities of the laser have on both the homogeneity of ionization of the discharge gap and the uniformity of

the electric field in the gap. The authors discuss problems of selecting beam energy and the structural elements of the laser when light foils are used. In calculating the distribution of ionization losses and electric field with respect to the height of the discharge gap, the energy of the monochromatic electron beam incident on the foil was varied as well as the average amplitude of the electric field applied between the cathode grid and the anode. An investigation was also made of the influence that the materials of the foil and anode, as well as the foil thickness have on the distributions of ionization losses and electric field. The results of the calculations can be used in drawing some conclusions relative to optimizing the parameters of the electron beams and foils, and also in determining requirements for design of electron-beam-controlled lasers. It is shown that using light foils in combination with reduced electron beam energy can increase the concentration of secondary electrons in the plasma, reduce the discharge cross section (by reducing the scattering angles in the foil) and also lighten biological shielding and simplify the installation. Light foils also lighten biological shielding and simplify the installations. Light foils also have low losses with respect to the energy and number of particles, which enables them to transmit a greater average power of the electron flux. For operation under optimum conditions it should also be borne in mind that if the beam energy changes by only 10-20 keV during a pulse, this may lead to redistribution of ionization losses over the discharge gap and to amplification of the electric field in the cathode or anode region. The authors thank A. A. Mak for useful discussion, and Yu. A. Anan'yev and N. N. Rozanov for continued interest and assistance in the work. Figures 7, references 24: 10 Russian, 14 Western. [24-6610]

USSR UDC 621.373.826.038.823

LASING MODES AND CHARACTERISTICS OF EMISSION OF A PHOTODISSOCIATION IODINE RING LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1705-1711 manuscript received 27 Nov 78

KURZENKOV, V. N.

[Abstract] Theoretical and experimental studies of the modes of stimulated emission of ring lasers show that an important role in the mechanism of lasing is played by the parameters and form of the amplification loop as determined by the type of active medium, the amplidude of pumping and the level of reverse signals. Previous research has not dealt with the properties of the photodissociation ring laser using atomic iodine, which is of particular interest because of the possibility for wide variation of its parameters. In this paper an experimental study is done on a number of the characteristics of such a laser, and the energy conditions and

properties of the output emission are studies. The experiments were done in a four-mirror cavity arrangement with measurement of energy, space-time and polarization characteristics. It is shown that the principal role in formation of the directions of stimulated emission are played by weak reverse signals, which in the absence of additional mirrors may arise as a consequence of parasitic reflections or scattering. Under conditions of flash-tube pumping the measurements show that dynamic waves of inhomogeneities influence the lasing threshold. This effect shows up in the space-time structure of the near-field pattern. It is shown that polarization of the output emission is linear in the absence of external magnetic fields. It is also shown that a ring laser can be used for studying amplification systems that suppresses self-excitation of the amplifier on resonator mirrors. The author thanks N. N. Rozanov for discussing the results, and also I. M. Belousova for a number of recommendations of practical value. Figures 5, references 10: 9 Russian, 1 Western.
[24-6610]

USSR UDC 621.375.826:534.8

A NEODYMIUM GLASS LASER WITH RADIATION INTENSITY CONTROLLED BY ULTRASOUND

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1740-1745
manuscript received 22 Dec 78

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[Abstract] The paper gives the results of an experimental study of the principal patterns that govern the process of neodymium glass laser modulation when longitudinal oscillations of the active element and the mirror are excited, and an examination is made of the mechanism of ultrasonic modulation of solid-state laser radiation. The experiments are done with ultrasonic excitation of the active element or one of the cavity mirrors in the 20-200 kHz range. The intensity is modulated with double the frequency of the stimulated ultrasonic oscillations with a simultaneous increase in the average peak intensity by a factor of 2-3. The total emission energy in a pulse remains unchanged. An investigation is made of the patterns of modulation as a function of the amplitude and frequency of ultrasound over a wide pumping range, and it is shown that these patterns do not depend on the type of active medium of the laser. An examination is made of the mechanism of ultrasonic modulation of solid-state laser emission. Figures 4, references 7 Russian.
[24-6610]

USSR UDC 612.378.325

INVESTIGATION OF THE PROPERTIES OF A LASER WITH UNSTABLE CAVITY AND ADDITIONAL FEEDBACK

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1773-1775
manuscript received 9 Jan 79

ANAN'YEV, Yu. A., GORYACHKIN, D. A., SVENTSITSKAYA, N. A. and PETROVA, I. M.

[Abstract] If an additional element such as a mirror or semiconductor plate is introduced into a laser with unstable cavity, a convergent wave can be produced that will enhance emission density in the paraxial zone and lower the emission threshold. Both of these effects may be useful in various practical applications. The authors investigate the case of an additional mirror that covers only part of the cross section of the cavity, which precludes the possibility of existence of closed trajectories within the framework of the geometric approximation. The experiments were done with a neodymium glass laser (active element 45 mm in diameter and 600 mm long) operating in the mode of free lasing. To simulate the case of low-gain media, only 200 mm of the active element was pumped. Under these conditions the optimum magnification M of an ordinary telescopic cavity (without the additional reflector) is 1.2-1.3. The use of such a cavity with M = 1.26 gives an output energy of about 30 J and angular divergence of radiation (at half amplitude) of about 1.5'. The emission threshold can scarcely be reached when M = 2 in an ordinary cavity. With an added reflector the output energy was even a little greater than 30 J with magnification M = 3.8. Only with a 100% reflector and M = 8.3 did the output drop to 12 J. The angular divergence was never less than 2', and reached 4.5' with M = 2 in the case of a 100% reflector. Thus it does not seem feasible to achieve satisfactory beam convergence by this technique. Figures 2, references 7: 6 Russian, 1 Western.
[24-6610]

USSR UDC 621.373.826

SOME RESULTS OF EXPERIMENTS ON A GASDYNAMIC CO_2 LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1775-1777
manuscript received 21 Jan 79

GORYACHEV, S. B., TIKHONOV, B. A. and SHARKOV, V. F., Institute of Atomic Energy imeni I. V. Kurchatov, Moscow

[Abstract] The paper gives the results of preliminary experiments on a CO_2 gasdynamic laser with heating of the working mixture of N_2-CO_2-He in a plasmotron. A specific energy output of 20 J/g and efficiency of about 1.2% are experimentally achieved in the cw mode at a stagnation temperature of 1700 $\pm$ 100 K and parameter p_0 h* of the order of 0.5 atm·cm or less when the total flowrate of the gas mixture is about 0.5 kg/s. Figure 1, references 4 Russian.
[24-6610]

USSR UDC 535.241.13

SPACE-TIME LIGHT MODULATOR FOR CONTROLLING LASER RADIATION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1780-1783
manuscript received 27 Nov 78, after revision 23 Mar 79

KUZOVKOVA, T. A. and NILOV, Ye. V.

[Abstract] The paper describes a principle for using an electro-optical crystal of KDP type to set up a nonuniform electric field so that these electro-optical crystals can be used in combination with polarizers for space-time light modulation with alternate action as a high-speed shutter and as a diaphragm with a soft edge. An experimental check has shown that the technique used for calculating electric fields in such modulators, establishing the reciprocal relation between design parameters and the distribution of light transmission with respect to the cross section of the crystal gives an error of no more than 10%. Figures 2, references 5: 4 Russian, 1 Western.
[24-6610]

USSR UDC 621.375.826:535.37

IMPROVING THE EFFICIENCY OF NEDYMIUM LASERS BY CONVERTING PUMPING EMISSION IN A FLUORESCING LIQUID

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1795-1798
manuscript received 7 Mar 79

VODOP'YANOV, K. L., IL'ICHEV, N. N., MALYUTIN, A. A., MATYUSHIN, G. A. and PODGAYETSKIY, V. M., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] An investigation is made of the influence that conversion of the pumping radiation spectrum by a fluorescing spectrum (a rhodamine 6G solution in ethanol) has on the emission energy of a neodymium YAG laser. An analysis is made of the way that the conversion efficiency depends on the concentration of fluorescing liquid and the type of active medium. The output energy of the laser in the free emission mode is doubled, the differential energy is increased by 50-130% and the lasing threshold is reduced by 10-20%. The experimentally measured values are compared with the results of calculation. Figures 3, references 11: 8 Russian, 3 Western.
[24-6610]

USSR UDC 621.373.826

GENERATION OF THE THIRD HARMONIC OF RADIATION OF A RUBY LASER IN THALLIUM VAPOR

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1801-1804
manuscript received 17 Jan 79

KIYASHKO, V. Ya. and TIMOFEYEV, V. P., Institute of Physics imeni L. V. Kiremenskiy, Siberian Department, Academy of Sciences USSR, Krasnoyarsk

[Abstract] One of the ways to improve the efficiency of laser conversion in parametric processes is by focusing into the center of a nonlinear medium, which increases pumping intensity and improves the conditions of phase matching of interacting waves. In this paper an investigation is made of the influence that the degree of focusing has on generation of the third harmonic of a ruby laser in thallium vapor. It is experimentally shown that as the focal length of the lens used for focusing decreases there is an increase in the maximum lasing signal, a shift into the high-temperature region and narrowing of the lasing curve. Figures 3, references 3:
2 Russian, 1 Western.
[24-6610]

USSR UDC 621.375.826:539.196.5

ON THE EFFICIENCY OF A SELECTIVE CO LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1816-1818
manuscript received 17 Jan 79

LIKAL'TER, A. A., Institute of High Temperatures, Academy of Sciences USSR, Moscow

[Abstract] A CO laser emits simultaneously on several vibrational-rotational bands from 5 to 8 μm. A selective cavity is used to isolate emission on a single frequency. Previous research has covered the efficiency of a CO laser with selective cavity. In this paper, more complete consideration is taken of the specifics of selective lasing. The limiting factor for efficiency is molecular transmission of quanta into the upper part of the vibrational spectrum with bypass of the lasing transition. The efficiency of the lasing transition is found as well as the law of gain saturation. Analysis is based on flow of excitation quanta in the vibrational spectrum corresponding to localization of pumping in the lower part of the spectrum, and quenching in the upper part. Figure 1, references 5: 4 Russian, 1 Western.
[24-6610]

USSR UDC 621.373.826+536.46

INFLUENCE THAT PARAMETERS OF A HYDROGEN FLUORIDE MIXTURE HAVE ON THE VELOCITY OF FLAME PROPAGATION

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manuscript received 5 Feb 79

BASHKIN, A. S., KOLCHIN, Yu. A., ORAYEVSKIY, A. N., PSHEZHETSKIY, S. Ya., CHEBOTAREV, N. F., YURYSHEV, N. N. and VAGIN, N. P., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] The rate of flame propagation in hydrogen fluoride mixtures is experimentally studied at atmospheric pressure. It is shown that if the mixture is diluted with a diatomic gas such as nitrogen instead of monatomic gases, or if the polyatomic gas SF_6 is added without any change in energy accumulation, there will be a sharp reduction in burning rate and an increase in the threshold pressure of fluorine where burning changes to detonation in the investigated conditions. The results show the feasibility of developing a pulsed periodic laser with high energy characteristics. Figures 2, references 4: 2 Russian, 2 Western.
[24-6610]

USSR UDC 621.373.8+621.375.826

CHARACTERISTICS OF PULSED LASING ON TRANSITIONS IN THE BARIUM ATOM

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 9, Sep 79 pp 1942-1947
manuscript received 16 Jan 79

ISAYEV, A. A., LEMMERMAN, G. Yu., MARKOVA, S. V. and PETRASH, G. G., Physics Institute imeni P. N. Levedev, Academy of Sciences USSR, Moscow

[Abstract] The paper presents the results of a study of the characteristics of lasing on atomic lines of barium with wavelengths of 1.5 and 1.13 μm. Lasing in barium vapor was studied in a conrundum discharge tube with inside diameter of 25 mm and length of the heated section of 85 cm. Water-cooled electrodes were used. Quartz plates with transmission that determined the investigated spectral region were cemented on the ends, cut at an angle of 4°. The density of the barium vapor was determined by wall temperature. Emission was stimulated by discharging a working capacitor through a pulsed thyratron. Excitation pulse duration was 200 ns with rise time of about 30 ns, and recurrence rates of 8 and 13.3 kHz. The average emission power is studied as a function of the buffer gas pressure and the supply power. The spectral and time characteristics were studied. A maximum average lasing power of 12.5 W was achieved at an efficiency of 0.5%. Maximum efficiency of the barium vapor laser is 0.72%. Figures 4, references 7: 5 Russian, 2 Western.
[28-6610]

USSR UDC 621.373.826.038.823

INVESTIGATION OF THE CHARACTERISTICS OF A FAST-FLOW CW CO_2 LASER STIMULATED BY A SELF-MAINTAINED DC DISCHARGE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 8, No 9, Sep 79 pp 1952-1959
manuscript received 22 Jan 79

BASIYEV, I. G., BLOKHIN, V. I., YEPISHOV, V. A., KUZ'MIN, V. N., MYSLIN, V. A., PASHKIN, S. V. and SHULAKOV, V. N., Institute of Atomic Energy imeni I. V. Kurchatov, Moscow

[Abstract] Experiments are done to determine the efficiency of a laser facility with rapid flow of carbon dioxide at elevated pressure. The accumulator of vibrational energy is atmospheric nitrogen. The water vapor in the air quenches the lower laser level of the CO_2 molecule and makes helium unnecessary. The vibrational levels of nitrogen are stimulated in a discharge chamber, and the carbon dioxide is added to the mixture downstream from the discharge chamber. This arrangement enables operation at high pressures of the working mixture. The airflow in the

discharge chamber was set by calibrated nozzles. Air temperature at the inlet was 20°C, and relative humidity was 60-80%. The anode in the discharge zone was a copper plate, and the cathode was made up of small steel rods distributed opposite the plate, each rod being connected to a power supply through a ballast decoupling resistor. As a result of optimization experiments, a laser was developed with CO_2 pressure of 100 mm Hg, flowrate of about 200 m/s, discharge chamber efficiency of about 0.7, and gain of 1%/cm. The authors thank Ye. P. Velikhov for initiating the work, and A. A. Vedenov for interest. Figures 5, references 9: 3 Russian, 6 Western. [28-6610]

USSR UDC 621.373.826.038.825

AN ELECTRON-BEAM ULTRAVIOLET SEMICONDUCTOR LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Sep 74 pp 2045-2046 manuscript received 27 Mar 79

KURBATOV, L. N., KOZINA, G. S., KOSTINSKAYA, T. A., RUDNEVSKIY, V. S., TKACHENKO, I. M., GEORGOBIANI, A. N. and GUTAN, V. B.

[Abstract] Experiments are done to develop a miniature laser emitter in the ultraviolet range. ZnS and ZnO crystals were stimulated by an electron beam with energy of the order of 115 keV. Current density was 60 A/cm^2. Multi-component targets were studied with transverse pumping. The targets were made by cementing single crystals to molybdenum bases with forced cooling. Laser pulses were triangular with duration at half-power of 3-5 ns at a recurrence rate of 12 Hz. Targets of ZnS produced stimulated emission only at 80 K, with power of 0.5-0.7kW. The ZnO targets emitted at both 80 and 300 K with maximum pulse power of 3-5 kW. The authors thank A. N. Lobachev, I. P. Kuz'mina and V. A. Kuznetsov for furnishing the single crystals. Figures 2, reference 1 Russian.
[28-6610]

INVESTIGATION OF THE ABSORPTION OF A MOLECULE OF SF_6 OVER A BROAD RANGE OF INTENSITY OF INFRARED LASER EMISSION

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 77 No 3(9), Sep 79 pp 816-828 manuscript received 5 Feb 79

KNYAZEV, I. N. and LOBKO, V. V., USSR Academy of Sciences Institute of Spectroscopy

[Abstract] The results are given of an investigation of the dependence of absorbed energy in SF_6 on the emission intensity of a CO_2 laser in the intensity range of 1 to 10^6 W/cm^2. The experiments were conducted

with a laser unit without continuous frequency tuning, at fixed frequencies of a CO_2 laser at the atmospheric pressure of the working mixture. With an intensity of approximately up to 10^4 W/cm^2, the results are interpreted by taking into account the weakly forbidden single-quantum transitions $\Delta R \neq 0$ and $\Delta n \neq 0$. Measurements were made of the absorption of the emission of a CO_2 laser in uncooled gas cells filled with SF_6, at a gas pressure of less than 0.4 torr for the purpose of excluding the influence of collisions. An electron-beam-controlled CO_2 laser was used, with a lasing pulse energy of 0.2 J maximum and a pulse duration of 150 ns with a laser mixture pressure of 1 atm. The laser's cavity consisted of a 100 lines/mm diffraction grating and a flat semitransparent mirror placed at a distance of 150 cm from one another. The spectrum width of the laser emission equaled approximately 0.008 cm^{-1}. A mixture of CO_2:N_2 = 1:2 was employed in the laser, and measurements were made at lasing lines P(14), P(18), P(22) and P(26) in the laser's 10.6 μm emission band. The absorption of SF_6 was measured at transitions in the R branch (the laser's P(14) line) and P branch (remaining laser lines) of the ν_3 band. The intensity range of 1 to $4 \cdot 10^6$ W/cm^2 was covered. The laser emission was directed at the absorbing cell and was then recorded by means of a cooled Ge:Au photodetector, whose minimum sensitivity equaled 10 W. Part of the laser emission was diverted at the inlet of the absorbing cell for the purpose of measuring the reference signal. The intensity of the emission at the cell's inlet was measured by means of sets of calibrated absorbing filters consisting of layers of a Teflon film 30 μm thick. Recordings were made of the signal at the outlet of evacuated cells and cells filled with gas while changing the intensity of the laser emission in the cells by means of the calibrated filters and comparing the measured and reference signals. With a known geometry for illumination of the cells, a determination was made of the total number of molecules in the absorbing volume of gas, the mean number of absorbed photons, and of a parameter, δ, close in the physical sense to the product of the many-quantum absorption cross section, σ, and the share of molecules, q, taking part in absorption. The results of studying the absorption of the emission of a CO_2 laser in the ν_3 band of SF_6 are presented graphically. The curves presented show the absence of sudden breaks in crossing the linear absorption saturation limit, and the formation of plateaus on the $\delta(I)$ curve with a laser emission intensity of up to 10 to 100 W/cm^2. In the low-intensity region the mean number of absorbed photons increases in proportion to the intensity, and the magnitude of δ is approximately constant, which is typical of linear absorption. Deviations from linear absorption begin to appear with a power density of 2 to 20 W/cm^2. An experimental determination is made of the nature of the transition from linear to many-quantum absorption in the intensity range studied. The behavior of absorption in the intermediate region of intensities of up to 10^3 to 10^2 W/cm^2 is explained satisfactorily in the quantitative sense by taking into account many-quantum and single-quantum weakly forbidden transitions $\Delta R \neq 0$ and $\Delta n \neq 00$. The experimental results are explained by taking into account transitions with a radiative transition cross section equaling only 0.005 times the corresponding value for allowed transitions.

With a higher emission intensity, absorption is explained by the formation of a sequence of secondary chains of many-quantum transitions and the intramolecular exchange of excitation energy between mode types. Figures 7; references 22: 6 Russian, 16 Western.
[31-8831]

USSR UDC 543.42

CERTAIN PROBLEMS OF THE INTERACTION OF LASER RADIATION WITH TITANIUM ALLOYS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 4, 1979
pp 606-611 manuscript received 21 Nov 78

GUSARSKIY, V. V., KUZYAKOV, Yu. Ya., SEMENENKO, K. A. and TIMOFEYEVA, L. N.

[Abstract] The erosion of a number of Ti alloys and bimetals was investigated as a function of the parameters of the laser source as well as of the physical and mechanical properties of the specimens. Erosion here is construed as the size (diameter and depth) of the craters formed in the specimen by laser radiation used as a means of microanalysis of the chemical composition of the specimens. Erosion was measured with the aid of a special micrometer. While crater diameter varied significantly only at near-threshold pumping lamp voltages, crater depth increased in direct proportion to the increase in voltage. The extent of erosion was inversely proportional to the Brinell hardness of some but not all Ti-base alloys, which points to the complexity of the mechanisms of interaction of the laser beam with Ti-base alloys. Tests of various sampling procedures show that the most effective procedure consists in the collection of the sample with the aid of a carbon tube of 2-4 mm diameter, and dissolving the sample by immersion in 5 cc H_2SO_4 (1:1). Figures 3; references 3 Russian.
[52-1386]

EXCHANGE INTERACTION BETWEEN AN ATOM AND A MULTIPLY CHARGED ION

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 77 No 3(9), Sep 79 pp 858-866 manuscript received 23 Feb 79

DUMAN, Ye. L. and MEN'SHIKOV, L. I., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Collision processes involving multiply charged ions determine key parameters of modern thermonuclear plants and heavy-ion accelerators. A description is given of a method which has been developed which makes it possible within the framework of a quasi-classical approach developed earlier (1965) to find an analytical expression for the energy of exchange interaction, $\Delta(R)$, between any atom and a multiply charged ion. The expression obtained within the framework of this method for the energy of exchange interaction is the first term of an expansion in terms of orders of triviality of $z^{1/2}/R$, where z is the charge of the ion and R is the internuclear distance. The test for the applicability of the results obtained is therefore $R \gg z^{1/2}$, an inequality which justifies the use of the quasi-classical method for finding the wave function of an electron in the subbarrier region. The energy of exchange interaction between an atom and a multiply charged ion is found with great distances between the nuclei of the colliding partners, i.e., $R > z^{1/2}$. The potential for exchange interaction, $\Delta(R)$, is expressed in terms of known parameters of the atom and multiply charged ion, i.e., the ion's charge, z, the binding energy for an electron in the atom, $\varkappa^2/2$, the magnitude of the orbital moment and of the spin of an electron in the atom and ion, where the projection of the orbital moment onto the axis connecting the nuclei is equal to zero. The quasi-classical method developed here properly describes interaction both in the intermediate region of distances between interacting partners where $4z^{1/2} < R < 2z$ and at the asymptotic limit of $R > 2z$. It is shown that there are two ranges of distances between interacting partners in which $\Delta(R)$ behaves differently as a function of the change in internuclear distance, R. In the range in which $R \gg 2z$, the equation for exchange interaction is transformed into the expression for the asymptotic case. The results obtained are easily generalized for the case when with great distances between partners the energy of exchange interaction is caused by the subbarrier transition of one of the outer electrons of the atom to an unoccupied level of the multiply charged ion. Figures 1; references 25: 12 Russian, 13 Western. [31-8831]

USSR UDC 621.373.826

SPECTRAL DETERMINATION OF PLASMA PARAMETERS WITH 0.5 μs TIME RESOLUTION

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 4, 1979 pp 592-596 manuscript received 9 Oct 78

BAKEYEV, A. A., VASIL'YEV, L. A., NIKOLASHINA, L. I. and PROKOPENKO, N. V.

[Abstract] The findings of an investigation of the plasma torch generated by exposing spectrally pure aluminum to the radiation of a neodymium laser operatiog in the free-running mode are presented. High-speed photography of the plasma radiation spectra with 0.5 μs time resolution was employed. The mean density of the flux of laser radiation directed at a target of 8 mm diameter was $\sim 10^7$ W/cm^2. The wavelength range selected for analysis was 440-470 nm, since it contains lines of Al^+, Al^{2+} ions and nitrogen ions with known transition probabilities and secondary Stark effect constants. The resulting pattern of action of laser radiation is such that it generates a high-pressure zone in the target. The heated aluminum vapors expand at supersonic velocities and, at some distance from the target, they form a quasi-stationary compression shock. The obtained spectrograms of the torch with 0.5 μs time resolution warrant the assumption that the supersonic motion of aluminum vapor generates a shock wave propagating through unperturbed air ahead of the aluminum vapor. The compression-shocked air becomes heated and begins to radiate upon passage of powerful spikes of laser radiation (lines of ionized nitrogen can be seen ahead of the aluminum vapor). Thus the abosrption of laser radiation in air may be promoted by its photoionization due to the radiation of the target's vapor. Figures 2; references 7 Russian.
[52-1386]

USSR UDC 535.212

SURFACE REDUCTION OF OXIDES AND THEIR COMPOSITIONS BY MEANS OF LASER RADIATION

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 4, 1979 pp 618-622 manuscript received 20 Jan 78

SKIBA, P. A. and NEPOKOYCHITSKIY, A. G.

[Abstract] Surface thermochemical reactions initiated by laser radiation, and in particular the reduction of metal oxides, are of major interest to various domains of technology. In this connection the possibility of broadening the range of such reduction was investigated on specimens of cupric and cuprous oxide, nickel oxide, ferric oxide, as well as the ferrite compositions M 400-NM, M 1000-NM, M 1500-NM, and M 2500 NM.

The specimens were placed in a chamber filled with alcohol or its vapor and then subjected to laser radiation. The course of the reduction process was traced as a function of the variation in conductivity of the specimens, as well as with the aid of x-ray diffraction patterns. It was found that reduction by means of laser pulses may occur in stages, from the higher to the lower oxide, e.g. from CuO to Cu_2O. As for the ferrites, these turned out to require special conditions. To assure firm bonding of the reduced metal film to the ferrite and to avert the cracking of specimens under laser radiation, they are heated to 100-200°C and reduced in alcohol vapor. The problem of the nonuniform depth distribution of the reduced metal coating, which complicates the welding, brazing, etc. of ferrites, can be solved by depositing on it a layer of another metal with technologically satisfactory adhesion, for example, by an electrolytic method. In general, the use of lasers to reduce metal oxides serves to obtain surface metal films of any geometry, and both pulsed and CW lasers can be used for this purpose. Figures 4; references 7: 6 Russian, 1 Western.
[52-1386]

USSR UDC 778.38

ON THE POSSIBILITY OF RECONSTRUCTING HOLOGRAMS WITHOUT A REFERENCE BEAM

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 4, 1979
pp 639-644 manuscript received 23 Nov 78

ABLEKOV, V. K., KOLYADIN, S. A. and FROLOV, A. V.

[Abstract] The possibility of reconstructing certain characteristics of the object-field distribution function from Fourier holograms lacking a reference beam is considered. On the basis of an analysis of the autocorrelation pattern of the picture it is shown that a priori information on the object can be obtained in the form of the field distribution function at the field boundary. Further, with the aid of optical filtration in the space frequency range, the first derivative of the field distribution function in the plane of the object can be reconstructed. This method for hologram reconstruction was used to obtain the true image of an object with diffuse scattering. A corresponding analysis of plane Fourier holograms lacking a reference beam is presented from the standpoint of the asymptotic representation of the Fourier integral in the space frequency range. Figures 4; references 4 Russian.
[52-1386]

NONSTATIONARY COHERENT EFFECTS IN THE PULSED EXCITATION OF HYPERFINE STRUCTURE TRANSITIONS IN OPTICALLY ORIENTED ATOMS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 77 No 2, Aug 79 pp 505-518 manuscript received 30 Dec 78

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[Abstract] In the simultaneous pulsed excitation of two neighboring hyperfine structure transitions in optically oriented atoms radio-frequency coherence is evidenced, associated with the origin of a transverse magnetization component. By analogy with ordinary magnetic resonance one would expect the manifestation of nonstationary coherent effects, such as nutation, free precession and spin echo. The results are given of an experimental and theoretical study of these nonstationary radio-frequency coherence signals in optically oriented atoms of cesium ^{133}Cs. Light pumped from a cesium tube in which an electrodeless high-frequency discharge was excited passed through an interference filter admitting only the D_1 line of cesium (wavelength of 8943 Å), and through a circular polarizer and fell on an absorbing cell filled with cesium vapors and an Ne buffer gas. The variation in absorption of the pumped light by the cell with magnetic resonance was recorded by a photodetector and the signal was amplified and registered on an oscillograph. The source of the SHF magnetic field used to induce hyperfine structure transitions in cesium atoms was a 10 GHz band microwave oscillator with a maximum output power of 500 MW. A rectangular horn antenna was oriented in relation to the H_0 field so that both $\pi(\Delta m_F = \pm 1)$ and $\sigma(\Delta m_F = 0)$ magnetic dipole hyperfine structure transitions could be excited. Coherence between Zeeman sublevels $F = 4$, $m_F = -4$ and $F = 4$, $m_F = -3$ of ^{133}Cs atoms was registered from the absorption of the transverse magnetization component, H_0, of the light beam from the cesium tube after passing through the above-mentioned filter and circular polarizer. For the purpose of observing radio-frequency coherence echo signals, artificial inhomogeneity of the magnetic field was created by means of opposing rings supplied from a d.c. source and supplied with a video pulse from a pulse generator for the purpose of inverting the magnetic field gradient. Multiple spin echo radio-frequency coherence signals were detected, excited by two succesive microwave pulses, as well as a radio-frequency coherence echo signal after a signal microwave pulse and subsequent inversion of the magnetic field gradient. A theoretical discussion is presented, of the effects observed, using an approximation of a three-level quantum system perturbed in a pulsed manner by two resonant variable magnetic fields. Multiple spin echo and complex nutation in radio-frequency coherence are discovered, which are coherent effects not observed previously. Theoretical expressions are derived for nonstationary coherence signals which have made it possible to explain the characteristic dependence of a nutation signal on the duration of the microwave pulse, and the manifestation of additional spin echo signals, as well as to determine the optimal conditions for the excitation of echo signals for the two methods of producing echo. Figures 8; references 19: 10 Russian, 9 Western.
[30-8831]

INERTIA OF THE PROCESS OF STIMULATED MANDELSTAM-BRILLOUIN SCATTERING AND NONTHRESHOLD REFLECTION OF SHORT PULSES WITH WAVE FRONT REVERSAL

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 77 No 2, Aug 79 pp 526-536 manuscript received 17 Jan 79

YEFIMKOV, V. F., ZUBAREV, I. G., KOTOV, A. V., MIRONOV, A. B., MIKHAYLOV, S.I., PASMANIK, G. A., SMIRNOV, M. G. and SHILOV, A. A., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev

[Abstract] In an earlier study it was demonstrated that in steady-state Mandelstam-Brillouin stimulated scattering it is possible to accomplish nonthreshold reflection of the weak signal with reversal of its wave front in the field of a strong wave for which the stimulated scattering threshold has been exceeded and the conditions for wave front reversal have been fulfilled. Nonthreshold reflection takes place only in the steady-state case when the characteristic time scales for the alteration of pulses are sufficiently great in comparison with the relaxation time of hypersound; in this case the reflection coefficients of the strong and weak pumping components are the same. In Mandelstam-Brillouin stimulated scattering of a short light pulse non-steady-state effects begin to play an important role and result in a difference in reflection coefficients and alteration of the shape of Stokes pulses in comparison with individual pumping pulses. A theoretical and experimental study is made of these phenomena. Wave front reversal and nonthreshold reflection are produced by two methods: in a light pipe, and by focusing the radiation in the active medium by means of a lens. Employed as the master oscillator was a neodymium laser with diffraction divergence and pulse duration at half-height of approximately 50 ns. The strong pumping component was achieved by coupling out part of the radiation from one face of a thick glass plate in order to avoid interference, and feeding it to an amplifier. A square pulse of 10 ns duration was isolated from the remaining part of the beam by means of a coaxial Pockels cell triggered by means of a spark gap. This pulse was also coupled to the amplifier from the face of the glass plate and acted as the weak pumping component. The active media in focusing with a lens were liquid CCl_4 and gaseous SF_6 at a pressure of 20 atm, and with a light pipe, liquid CS_2 and gaseous methane at a pressure of 150 atm. In experiments with a light pipe, both waves were brought together on a phase plate and the image of the lit area was transmitted by means of a lens with a focal length of 20 cm to the input of the light pipe. A rectangular metal light pipe was placed in the cell with methane, and a round glass light pipe was used for CS_2. A 17 cm focal length lens was used to focus the radiation in the active medium in the second method. A recording was made of the distribution of radiation in the back-scattered waves, of the strong and weak pumping components, respectively, in the close-range and remote zones; of their energy; and also of the shape of pulses. It was found that there is considerable pulling of the back-scattered pulse when its duration is shorter than or comparable with the relaxation time of hypersound. Under these

conditions there also takes place a reduction in the reflection coefficient of the weak pumping component as compared with that of the strong component. A method is suggested and modeled for producing fairly short pulses with wave front reversal under nonthreshold conditions. Pulses of this sort are required for many applications, for creating and studying laser plasmas, in particular. It is demonstrated that nonthreshold reflection with Mandelstam-Brillouin stimulated scattering in media with a short lifetime of acoustic phonons, CCl_4, for example, where the lifetime is less than 1 ns, makes it possible to achieve the wave front reversal of pulses with a duration of greater than 0.5 ns with a reflection coefficient of greater than 10 percent. A theoretical interpretation is given of the experimental results. Figures 6; references 6 Russian.
[30-8831]

USSR UDC 621.378.35

INFLUENCE THAT MISALIGNMENT OF THE ELEMENTS TO BE MATCHED HAS ON THE EFFICIENCY OF COUPLING INJECTION SEMICONDUCTOR LASER RADIATION INTO OPTICAL FIBERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1761-1766
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MIRONOV, Yu. M. and SEMENOV, A. S., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] In coupling injection laser emission into optical fibers, problems arise that are due to the divergence of the laser beam and the strong ellipticity of the far field of the laser radiation. Without special matching, only 20-40% of the emission power can be coupled into multimode fibers, and only 3-5% into single-mode fibers. Previous research has shown that a section of gradient-index light guide can considerably increase the effeciency of coupling injection laser radiation into optical fibers. In this paper an examination is made of the influence that a deviation from coaxiality of the optical elements has on the efficiency of matching. It is shown that there are no qualitative differences in the requirements for alignment of the elements to be matched with or without a section of gradient-index light guide. The authors thank V. V. Nikitin for useful discussion of the results. Figures 3, references 9: 3 Russian, 6 Western.
[24-6610]

USSR UDC 621.391.029.7

INVESTIGATION OF THE WAY THAT THE PASSBAND OF A MULTIMODE FIBER-OPTICS LIGHT GUIDE DEPENDS ON CONDITIONS OF EXCITATION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1767-1770
manuscript received 20 Oct 78

BUBNOV, M. M., GRUDININ, A. B., DIANOV, Ye. M. and SENATOROV, A. K., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] An investigation is made of the way that the passband depends on conditions of excitation of light guides developed jointly by the Institute of Chemistry and the Lebedev Physics Institute of the USSR Academy of Sciences. These light guides are made by chemical deposition from the gas phase. Approximate formulas that express the dependence of the passband of the light guide on conditions of excitation are derived on the basis of an analytical expression for the transfer function of a light guide with step-graded index of refraction. This relation is

experimentally studied. The method developed enables measurement of the passband of light guides with index of refraction distributed over the cross section. Figures 4, references 6: 1 Russian, 5 Western.
[24-6610]

USSR UDC 621.396.22.029.7

LONG-DISTANCE WAVEGUIDE TRANSMISSION OF IMAGES IN COHERENT LIGHT

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6, No 8, Aug 79 pp 1804-1807
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[Abstract] Based on the example of a cylindrical waveguide with square-wave medium the author shows the theoretical possibility of transmitting optical images to great distances over multimode waveguides (from hundreds of meters to a few kilometers). Expressions are derived that determine the location of long-range cross sections where the image is formed, and the number of image elements that can be transmitted to these sections. Requirements are formulated for the source of emission with consideration of chromatic aberrations of the waveguide. The author thanks L. A. Rivlin and S. D. Yakubovich for interest in the work and useful discussion. References 3: 1 Russian, 2 Western.
[4-6610]

SUPERCONDUCTING PROPERTIES OF GERMANIUM UNDER HIGH PRESSURE

Leningrad FIZIKA TVERDOGO TELA Vol 21 No 8, Aug 79 pp 2321-2324 manuscript received 6 Mar 79

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[Abstract] The results are given of a study of the superconducting properties of the high-pressure phase of germanium with different conductivity types and initial concentrations of carriers. Samples of p- and n-type Ge were used with a carrier concentration in the range of 10^{12} to 10^{19} cm^{-3} under a pressure of from 8 to 13 GPa. Measurements were made with a special fixed pressure unit in which the high-pressure cell was in the form of three pyrophillite disks between which were placed two samples, each of which was supplied with four electric leads to the high-pressure region. This made it possbble in a single experiment to make a simultaneous measurement of either two samples of Ge with different initial concentrations or of one sample of Ge together with a reference metal such as Bi, Sn or Ba. The Ge samples were cut out by the electrosparking method from single-crystal bars and were then etched. The transition into the superconducting state was recorded by the drop in resistivity to zero in a sample compressed at room temperature to a specific pressure. The dependences are shown, of the temperature of the superconducting transition, T_c, on the pressure, P, for all the Ge samples studied. In the low-pressure region the $T_c(P)$ dependence grows rapidly with an increase in pressure. At a pressure of about 9 GPa linear dependences of $T_c(P)$ are observed with negative values of dT_c/dP different for samples with different initial concentrations of charge carriers. In the pressure range of 9 to 13 GPa the value of the critical temperature, T_c, with the same pressure varies nonlinearly both for p- and n-type Ge as a function of the value of the initial concentration of carriers. Dependences of dT_c/dP on the value of the initial concentration of charge carriers are plotted for samples of Ge of both types, where it is shown that in the concentration range of 10^{14} to 10^{17} cm^{-3} extrema are observed. The relatively great changes in the value of T_c with a change in impurity concentrations of a relatively low value make it possible to suggest that the electron spectrum of the Ge II phase is most likely the spectrum of a semimetal or of a degenerate semiconductor. In an earlier study, a radiograph of a sample of germanium obtained at a pressure of about 9 GPa showed the presence of only two phases, i.e., the original Ge I and Ge II high-pressure phases belonging to the beta-Sn structural type. The manifestation of the dependence of dT_c/dP found on the impurity concentration, in addition to the nonlinear dependence of the critical temperature T_c on the concentration, is caused by the influence on superconducting properties of changes taking place in the electron-phonon structure of the high-pressure phase of Ge. Figures 3; references 11: 6 Russian, 5 Western.
[29-8831]

INFLUENCE OF DIELECTRIZATION OF ELECTRONS ON OPTICAL PROPERTIES OF SUPERCONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21 No 8, Aug 79 pp 2351-2359
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[Abstract] A study is made of the influence of the dielectrization of electrons on the optical properties of semiconductors. The study consists of two sections. In the first, optical properties are discussed of a system with simultaneous electron-electron and electron-hole pairing at $T = 0^{o}C$. The reference is a model of a doped semimetal which is unstable in relation to electron-hole and Cooper pairing. In the limiting case of the semimetal's dielectric gap's being much smaller than the Debye frequency, which in turn is much smaller than the Fermi energy, the reciprocal influence of Cooper and dielectric pairing results in reordering of the entire spectrum of elementary excitation. The second section discusses the absorption of light in this system with other limiting conditions, i.e., with the Debye frequency much smaller than the shift in the Fermi level resulting from doping, which in turn is much smaller than the dielectric gap. In this case, after the dielectric transition the excess of carriers present because of doping remains above the gap and the system is a degenerate semiconductor. A superconducting gap is formed at the chemipotential level in the dielectric phase and causes reordering of the spectrum only near the chemipotential, and here electrons of the completely filled valence band do not participate in superconducting pairing as in the previous case. In the first case reordering of the entire spectrum of elementary excitation in the dielectric phase resulting from the superconducting transition results in the appearance of four branches in the excitation spectrum. In the absorption of light, optical transitions between different branches in the elementary excitation spectrum are shown to be possible, in addition to processes with the breaking of a Cooper and electron-hole pair. This phenomenon is illustrated by the appearance of two breaks on the absorption curve. In the second case, where superconducting reordering of the spectrum takes place only near the level of the chemipotential in the dielectric phase, the absorption coefficient as a function of frequency, depending on the ratio between the Debye frequency, the shift in the Fermi level resulting from doping, and the dielectric gap, can have a peak slightly higher than the threshold frequency. The compounds studied here, in which the superconducting transition is preceded by a structural one, represent the most high-temperature superconductors. The results obtained can be used for a qualitative description of the optical properties of doped superconducting semiconductors of the A_4B_6 (GeTe, SeTe) group in which structural transformation has been observed. Superconducting pairing is possible if the Fermi level after dielectric pairing is just partly beyond the dielectric gap, which occurs with the existence of an elevated density of states

resulting in the possibility of a substantial increase in the superconducting temperature. Figures 3; references 18: 12 Russian, 6 Western. [29-8831]

USSR UDC 537.312.62

INVESTIGATION OF THE HIGH-FREQUENCY PROPERTIES OF SUPERCONDUCTING POINT CONTACTS IN THE FAR-INFRARED REGION OF THE SPECTRUM

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manuscript received 1 Dec 78

BASOV, N. G., BELENOV, E. M., VEDENEYEV, S. I., GUBIN, M. A., MOTULEVICH, G. P., NIKITIN, V. V., SPETANOV, V. A. and USKOV, A. V., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] A theoretical and experimental investigation is made of the high-frequency properties of superconductive Nb-Nb point contacts that operate under nonequilibrium conditions with high critical current I_c and low resistance of the normal state R_N to study the feasibility of using them for metrology in the near infrared. It is shown that when such contacts are exposed to external emission, their current-voltage curves show obvious current steps that correspond to the harmonics of the external signal frequency at voltages that exceed the limit for niobium superconducting point contacts. In this case, a capacitive frequency limit appears. Weak links with dimensions of no more than 50 nm show frequency multiplication right up to $8 \cdot 10^{12}$ Hz (about 38 μm). An investigation is made of the way that the stepped structure of the current-voltage curve depends on the power and frequency of the external signal, and also the way that the amplitude and linewidth of the intermediate frequency signal depend on the bias voltage and power of the external signals when the contacts are exposed to emission from two sources. Theoretical analysis shows that in frequency multiplication and mixing by superconducting point contacts that operate in the nonequilibrium mode it is necessary to account for the effect of both the emission itself and its harmonics. Figures 12, references 16: 8 Russian, 8 Western.
[24-6610]

- END -

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PHYSICS AND MATHEMATICS

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HOLOGRAPHY ADVANCES NOTED

Moscow IZVESTIYA in Russian 9 Dec 79 p 3

[Article by S. Davitaya, IZVESTIYA correspondent, Tbilisi: "A Window Looking Into the Future"]

[Text] In recent years unusual pictures -- holograms -- have appeared at dozens of scientific centers throughout the world and at various international exhibits. I am looking at one: old-fashioned silver adornments -- beads, artfully crafted Georgian chased bracelets. The picture is so three-dimensional and realistic that one involuntarily extends one's hand to grasp the real thing, but it strikes an invisible obstacle -- the surface of a plate. The objects appear to be positioned deeper, as if behind the glass of a museum display case, and yet in actual fact the picture is absolutely plane, and the chased adornments, in all the perfection of their skilled craftsmanship, are merely an apparition, a mirage, which carries, however, important information on the original.

But much more distinguishes the hologram from the ordinary photograph. A photograph or drawing gives an idea about certain external features of an object, but the image obtained is not alive. A hologram, however, of a mirror, for example, will reflect just as an actual mirror, everything you place before it. A hologram of a lens will reproduce the principal properties of the lens. This occurs because a holographic record of the light waves reflected by an object contains complete information on these waves, that is, about the object itself (the Greek word holography means "complete record"). In addition, on one and the same photographic plate, by merely changing the angle of its illumination, one can record an infinite number of holograms, and each of these can be read if one directs onto the plate a laser beam at the same angle at which the recording was made. This is an extremely economical method of storing information, is it not?

Where else in nature have we encountered such capacity? Perhaps only in the functioning of the human brain. One is drawn to continue the analogy. Does not the amazing flexibility and reliability of the brain, the cells of which are capable of taking over the functions of cells which have become disabled, of replacing them in large measure, have something in common with the no less amazing property of holograms to store at each point information on the entire object?

Customarily a hologram is justifiably compared with a window open to the world. Regardless of the angle of view we select -- leaning against the left or right side of the window frame, resting our chin on the windowsill or climbing up on it -- the view from the window will remain essentially the same. It is merely that we, changing our point of viewing, will see some things in greater detail, while others will disappear from view.

About 20 years ago Corresponding Member of the USSR Academy of Sciences Yu. Denisyuk, head of the Soviet school of holography and a Lenin Prize recipient, developed a method of so-called reflecting holography in a three-dimensional medium, which enables one, in addition to the volume of an object, to record its color as well. In other words this scientist succeeded in putting to harness wavelength, which determines sensation of color, and amplitude -- luminosity and phase -- which roughly speaking reflects the distance of an object -- three light characteristics. There remained polarization, but polarization is invisible to the human eye....

A team of young physicists at the Georgian SSR Academy of Sciences Institute of Cybernetics, under the direction of Shermazan Dmitriyevich Kakichashvili, began their pioneer work in holography in 1964.

...In the soft reddish light of a special reflector, behind a circular transparent shell (as if in the center of a cylinder) -- can you beat that? -- the living head of the laboratory director, right down to the finest details. One's groping hand, lowered into the cylinder, grasps emptiness, but the head is there in plain sight.... One can turn the head to the right, to the left, and turn the back of the head forward. A rather eery impression.... "Isn't it a little frightening to see your own head there, detached from your body?" I asked Kakichashvili. "No," he laughs. "It is even interesting to recall how young I was 7 years ago."

Of course this hologram was made by no means for amusement. For the first time in history a living object was recorded on a circular hologram, with a ruby pulsed laser built in this laboratory. Development of the circular hologram created the possibility of turning to one's hearts content not the live object itself but its "ghost," which carries, however, complete visual information on it.

Judge for yourselves how attractive such a capability would be to the biologist, physician, and... physicist, who would be able to "catch" the elusive motion of elementary particles in bubble chambers and Wilson cloud chambers. A vast expanse of problems, one more fascinating than the other, had opened up before the young team of scientists. In 1969 they took the first holographic film, only 200 frames in length, but perhaps this film was fated to become a stepping-stone to the art of the future.

Understandably a step from a holographic picture to holographic motion pictures is inevitable, just as the following step -- to holographic television.

You will recall that we mentioned that three basic characteristics of a light wave are utilized in holography to create a visual image -- wavelength, amplitude, and phase. We omitted the fourth and final dimension -- polarization -- because it is not perceived by the human eye and therefore does not directly influence the visual image. But the property of polarization is widely employed in modern science -- crystal physics, ellipsometry, and polarimetry. On the basis of direction and shape of oscillations of light waves, investigators determine the structure of a substance and processes invisible to the eye.

The idea of a truly complete (including polarization) record of information by holographic means became the principal motivation for Sh. Kakichashvili in 1966. A theory was born, but "its results were so strange, literally discouraging at the scientific level," the scientist related, "that we refrained from publishing our results. For some time we all became transformed into chemists, in order to obtain optimal materials for recording polarization. Incidentally, even now we are apparently the only producers of these media. By 1971 numerous experiments with various materials confirmed the correctness of our theory, and on 10 May of this year the USSR State Committee for Inventions and Discoveries registered our discovery: "Phenomenon of Reproduction of the Wave Pattern of an Electromagnetic Field."

Thus polarization holography was born. What new things does it offer? First of all man obtains a reliable method of recording and storing information, involving polarization. In addition, he acquires a new tool for scientific research in all areas where light is utilized. With the aid of polarization, for example, the structures of living tissues at the cell level are investigated in biochemistry and biophysics, the strength of structures in mechanics, while absorption of light in the interstellar medium is studied in astrophysics.

The Tbilisi physicists, under Kakichashvili's direction, are elaborating a theory according to which certain changes in the polarization pattern of a holographic image (in comparison with testing) enable one to determine the shape of molecules. But this is only a first step into the alluring depths....

Dennis Gabor, the founder of holography, once said: "Everything has its end, but the end to applications of holography is not in sight...." We must agree with him, especially when one realizes that everything we have mentioned up to the present time is only a small part of the possibilities of holography connected with recording light waves. A "complete record" of information on an object can theoretically be obtained with the aid of radio waves, sound, as well as infrared or X-rays. The limiting factor lies only in the technical recording capabilities. The Tbilisi physicists are working successfully with ultrasound.

The property of ultrasound to alter the velocity of its propagation in relation to the density of the medium through which it passes is widely

utilized today both in medicine, where organs and tissues are "probed" with its assistance, and in various branches of industry, where ultrasonic flaw detectors are employed. What is inside it? a person inquires. His reply is a pattern on an oscillograph. A signal indicating a cavity in the body of a turbine or aircraft, or a thickening in human tissues is of course a result of no small significance. But you will agree that for a doctor or designer it is a very attractive prospect to see with one's own eyes the shape, position and all kinds of parameters of that internal defect on which his attention is focused. This can be achieved with the aid of holography.

Water is presently playing the major role in experiments being performed by the Tbilisi physicists. There is an ultrasound source at the bottom of a small pool. Let us say that there is an egg in the path of the emitted waves. Penetrating it, the ultrasonic waves form on the water surface an intricate pattern which contains all information on the internal structure of the egg. A laser beam "reads" this information from the water surface. Three-dimensional filters are placed on its path to a photographic plate, which enable investigators to specify a different depth for a future image and to obtain on a hologram slices of the object, as it were. But they are of the opinion that water is not ideal. A water surface can be successfully replaced by a polymer film. Several types, which magnify image brightness 10-fold, have already been developed.

As a conclusion one generally presents the reader with a picture of the near or distant future. I should like to imagine a medical consultation taking place in a small circular office or auditorium, the walls of which constitute a circular screen. The subject of discussion is the stomach of patient X. and everything which is taking place in it. The exchange of opinions is distinguished by particular concreteness and exactness, because the subject of discussion -- that specific stomach -- is depicted with all its walls in an image surrounding the consultation group, an image obtained from a circular hologram.

Such a medical consultation could take place in the future. I was shown a miniature instrument for taking holograms of cavity internal organs at an optical research laboratory. And this means that how soon the imagined picture from the future becomes a reality of today depends not so much on the scientists as on many others, perhaps including you and me.
[82-3024]

3024
CSO: 1862

USSR UDC 534,87

CERTAIN FEATURES OF THE CORRELATION OF PSEUDONOISE SIGNALS REFLECTED FROM A STRATIFIED OCEAN BOTTOM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 25, No 6, 1979 pp 854-859
manuscript received 11 Mar 79

VOLOVOV, V. I., KRASNOBOROD'KO, V. V. and LYSANOV, YU. P., Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences

[Abstract] Analysis of experimental data obtained from the deep-water ocean regions has shown that the cross-correlation between the noise signal reflected from the ocean bottom and the emitted signal is characterized by several peaks due to the stratified structure of the ocean bottom in these regions, with each peak due to reflection from a different layer boundary. In this connection certain features of the cross-correlation of pseudonoise signals reflected from an underwater bottom consisting of N layers with statistically uneven boundaries are analyzed. A formula for determining the coefficients of reflection from different layer boundaries on the basis of measurements of some one reflection coefficient (e.g. for the water-ground boundary) by some autonomous method is presented. The calculations show satisfactory agreement with experiment. Figures 4; references 9: 7 Russian, 2 Western.
[81-1386]

USSR UDC 534.222

DETERMINATION OF THE ACOUSTIC INHOMOGENEITY OF A MEDIUM BY MEANS OF SONIC SIGNALS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 25, No 6, 1979 pp 860-867
manuscript received 19 Dec 78; after editing, 22 May 79

VORONOVICH, A. G. and MAL'TSEV, N. YE., Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences

[Abstract] Sonic waves propagating in inhomogeneous media undergo scattering. This raises the question of whether it is possible to derive the parameters of an inhomogeneity from the values characterizing the passage of acoustic signals across it. In this connection the one-dimensional idealized problem of a half-space in which the speed of sound depends on a single spatial coordinate z, and which is bounded by a rigid plane when $z = 0$, is considered, on assuming that at the instant $t = 0$ that plane undergoes the instantaneous displacement A_0 along the normal. Specifically,

the speed of sound is determined as a function of the spatial coordinate c(z). The problem is solved in the one-dimensional case by reducing it to the converse problem of the quantum theory of scattering. It is shown that in the presence of weak inhomogeneities the c(z) profile can be reconstructed over the scattered field computed in the Born approximation. Corresponding calculations also are performed for a point source in a real geophysical situation--the profile of the speed of sound in the ocean is determined according to the scatter of the field of a point source. References: 5 Russian.
[81-1386]

USSR UDC 534.8

ULTRASONIC METHOD FOR INVESTIGATING HYDRODYNAMICAL CAVITATION IN A VISCOUS FLUID

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GLINSKIY, V. A., KOL'TSOVA, I. S., MIKHAYLOV, I. G. and POKROVSKAYA, I. YE., Physics Department, Leningrad State University imeni A. A. Shdanov; Scientific Research Physics Institute

[Abstract] A method for ultrasonic probing of the cavitational plume generated by the flow of a viscous fluid through an aperture (throttle) in a thin wall into a variable-pressure chamber is proposed. The method is based on the principle of the additional attenuation of ultrasonic waves by gas bubbles. It is shown that probing by means of a high-frequency ultrasonic beam serves to pinpoint the region of appearance of gas bubbles within the cavitation plume and to study their spatial distribution, i.e. to determine the structure of the plume. The proposed scheme of the formation of cavitation bubbles allows for two opposed processes in the throttle--the formation of cavitation bubbles in the low pressure region, and their collapse in the region of increasing pressure. It is also shown that the ultrasonic method serves to determine the dependence of the concentration of cavitation bubbles in a fluid on the distance traveled by the flow after its throttling. The method described can also be used to investigate acoustic cavitation. Figures 5; references: 11 Russian.
[81-1386]

USSR UDC 534.222

UNSTEADY QUASI-ONE-DIMENSIONAL ACOUSTIC FLOW IN UNBOUNDED SPACE WITH ALLOWANCE FOR HYDRODYNAMICAL NONLINEARITY

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GUSEV, V. E. and RUDENKO, O. V., Physics Department, Moscow State University imeni M. V. Lomonosov

[Abstract] Acoustic flow is described by the equations of motion of an incompressible fluid in an inhomogeneous force field determined by the pattern of the diffraction and attenuation of the sonic beam. In the one-dimensional case, the system of the pertinent equations becomes sufficiently simplified to allow investigating both steady and unsteady flow in a tube. If, however, an unbounded sonic field is considered, with the radius of the tube reaching infinity, the flow rate will unboundedly increase. In this connection, a new simplified system of equations describing unsteady quasi-one-dimensional acoustic flow in an unbounded sonic field is derived. The determining role of hydrodynamical nonlinearity in the process of the onset of the acoustic wind is established, and an exact solution of the nonlinear unsteady problem is derived. The acoustic flow arising with propagation of a diffracting sonic beam in a medium is considered by way of an example. The newly derived system of equations, based on a simplification of the equations of cylindrically symmetric flow, is suitable for the solution of many other problems, such as analysis of the propagation of waves in moving media, or the numerical solution of nonlinear acoustohydrodynamic problems, since the premises on which it is based are sufficiently broad. Figures 2; references: 7 Russian.
[81-1386]

USSR

EFFECT OF SELF-ENHANCEMENT FOR ACOUSTIC WAVES IN A LIQUID WITH GAS BUBBLES

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 7, 5 Oct 79 pp 423-425 manuscript received 6 Aug 79

KOBELEV, YU. A., OSTROVSKIY, L. A. and SUTIN, A. M., Institute of Applied Physics, Academy of Sciences USSR

[Abstract] Acoustic phenomena in a liquid with gas bubbles are compared to electromagnetic effects in a plasma. In particular, resonant absorption of sound in such a two-phase medium is compared to collisionless attenuation. Acoustic solitons have also been observed. The physics of the

acoustic process becomes complicated particularly in cases where the acoustic field changes the state of the gas medium. The authors describe an effect of self-enhancement that is attributable to such action. Experiments were done in a bath measuring 40 x 40 x 80 cm. An acoustic wave was produced by a piezoceramic emitter, and the signal was picked up by a piezoelectric transducer 20 cm away. Bubbles were set up by electrolysis. Weak acoustic waves are strongly attenuated by a bubble layer, but an increase in wave intensity causes an abrupt drop in attenuation. An investigation of the influence of the acoustic field on the size distribution of bubbles showed that there is a sharp drop in the number of bubbles in the measurable size range with an increase in the pressure of the acoustic wave. This self-enhancement effect is attributed to grouping and merging of bubbles under the influence of the Bjorknes force that arises between two oscillating bubbles. The plasma analog is the effect of self-enhancement of Langmuir waves due to their influence on the distribution function. Figures 3, references: 5 Russian.
[59-6610]

USSR

A NEW TYPE OF MAGNETOACOUSTIC OSCILLATIONS IN THIN METAL LAYERS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 613-616 manuscript received 17 Sep 79

GOKHFEL'D, V. M. and PESCHANSKIY, V. G., Donetsk Physico-Technical Institute of the UkrSSR Academy of Sciences; Physico-Technical Institute of Low Temperatures, UkrSSR Academy of Sciences

[Abstract] Kinetic effects in conductors that are thin compared with the free path length of charge carriers ($d \ll \ell$) differ qualitatively from the effects in massive conductors, owing to the interaction between the electrons and the metal boundary. This interaction may be of the "mirror reflection" kind. In this connection, collision with the metal boundary may result in electron transfer to, e.g. the other cavity of the Fermi surface intersecting the $p \times n$ = const line at several points. Such "surface transfers" may manifest themselves in the kinetic effects by altering the dependence of the ultrasound absorption factor on the magnetic field applied. This occurs during the propagation of a sound wave along the normal to a thin metal layer with two convex Fermi-surface cavities. Then in the magnetic field parallel to the layer the electrons colliding with one of the layer's boundaries move along open trajectories. It is shown that the attendant processes of energy transfer may result in large-amplitude magnetoacoustic oscillations. Unlike the conventional magnetoacoustic effects, the period of these oscillations contains information

on the mutual alignment of discrete Fermi-surface cavities. Figures 1; references: 5 Russian.
[66-1386]

USSR UDC 533.082.5

INVESTIGATION OF ACOUSTIC WAVES IN A DECAYING ARGON PLASMA FROM A PULSE DISCHARGE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 4, Jul-Aug 79 pp 711-716 manuscript received 19 Jun 78

SKREBOV, V. N. and EYKHVAL'D, A. I., Leningrad State University

[Abstract] Acoustic waves were studied interferometrically for a decaying pulse discharge plasma in argon (10 mm Hg, 2-3 kV, pulse length 5-20 μsec, tube diameter 20 mm). The cylindrical acoustic wave was repeatedly reflected producing periodic radial compression with large (2-3X) relative increase in density, resulting in modulation of the discharge brightness. An optical interferometer was used to measure the concentrations of electrons and atoms along the axis of the discharge. Two regimes were noted, depending on electron concentration. In the first (electron number 1-5 x 10^{15} cm^{-3}) the increase in brightness was less than the increase in density and was the same for all lines. In the second (electron number 1-3 x 10^{14} cm^{-3}) the high-frequency lines increased in brightness approximately as the cube of N_e and the low-frequency lines approximately as the square of N_e. The intensity increased everywhere when the plasma was compressed on the axis. In regime 1 the primary role was played by electron-atom collisions. Radiative processes became more important as the electron concentration decreased. In regime 2 the main factor was spontaneous radiation after population of upper levels, proportional to the recombination flux, In regime 1 the electron temperature increased with compression; conditions were approximately adiabatic, so that T_e increased by 1.8-2X on first compression. In regime 2, because the recombination is a strong function of temperature, the cubic relationship can be explained by assuming that the acoustic waves were electron-isothermal (T_e = const), which also explains the square relationship for low-level transitions. As regards the mechanism of electron-temperature modulation, in regime 2 the high electron heat conductivity and low heat exchange with heavier particles results in a slow change in T_e on compression. In regime 1, fast equalization of electron and ion temperatures produces a high heat capacity and results in a small role for heat conductivity, producing an adiabatic situation. Figures 3, references 14: 12 Russian, 2 Western.
[87-8480]

USSR

THE SEMICONDUCTOR-SEMIMETAL TRANSITION IN THE ALLOY $Bi_{0.925}Sb_{0.075}$ UNDER TENSION

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 1971-1973 manuscript received 1 Feb 79

BRANDT, N. B., KOLOSOV, V. N., KUL'BACHINSKIY, V. A. and MININA, N. YA., Moscow State University imeni M. V. Lomonosov

[Abstract] General compression produces semiconductor-metal transitions in many substances. Single-axis deformation should produce special effects resulting from symmetry change, but these have not yet been observed because of the small size of achievable deformations. In the present study, a force sufficient to produce a deformation on the order of 0.5% was applied to an elastic ring containing a single crystal disk of the alloy $Bi_{0.925}Sb_{0.075}$ 3 mm in diameter. Current and voltage contacts along the load axis were used for measurement. The effect of tension on the bismuth energy spectrum is to disrupt the equivalence of extrema of L points in the Brillouin band so that one of two extrema drop with respect to the valence band ceiling, increasing the degree of overlap and raising the concentration of current carriers. Transition to the metallic state should result from overlap between L and T_{45} terms. Tension on the C_1 and C_2 axes was investigated at 4.2 K with fields ranging up to 45 kOe. Without tension the alloy was a semiconductor with a gap of about 10 meV between the L_a and L_s terms. A sudden drop in resistance was observed at $\sigma_k \sim 10$ kgf. The resulting characteristic degenerate carriers can be used to study isoenergetic surfaces by oscillographic methods. When $\sigma > \sigma_k$, Shubnikov-de Haas oscillations result. The frequency increased with load. The relation of the extremal cross sections of the Fermi surfaces to load was studied over all angles of rotation of H in the binary and bisector planes. The binary-plane Fermi surface included one electron and one hole ellipsoid; the minor axis of the electron ellipsoid coincided with C_2 (parallel to the force) and was inclined at about 6° from the base plane. For the bisector, the Fermi surface was one hole and two electron ellipsoids symmetrical to load axis C_1. There was no change in the angle of inclination of the isoenergetic surface of anisotropy when the load was increased from 18 to 26 kgf. With maximum loads, the oscillation had a frequency of about $1.2 \cdot 10^{-42}$ $(g\text{-}cm/sec)^2$, apparently corresponding with the minimum section of the hole ellipsoid at point T. It is concluded that the semiconductor-metal transition results from overlap between L_a and T_{45} terms. Figures 3, references 4: 3 Russian, 1 Western.
[191-8480]

USSR

INFLUENCE THAT RECIPROCAL EXCITATION AND PHONON DRAG HAS ON THERMOELECTRIC AND ACOUSTOELECTRIC EFFECTS IN SUPERCONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 1978-1985 manuscript received 1 Feb 79

GUREVICH, L. E. and KRYLOV, YE. T., Physico-Technical Institute A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A method of calculating the thermoelectric coefficient with allowance for reciprocal drag of excitations and phonons is presented. The relative contribution of the phonon wind is considerable if the phonons are scattered primarily on excitations rather than defects. In this case the thermoelectric coefficient is practically independent of the electron-phonon interaction constants, in contrast with results obtained by considering only the phonon drag on excitations or neglecting drag altogether. The calculation assumed a single-band super conductor whose electron spectrum is quadratic and isotropic, with only one phonon mode, LA, considered. The method of Landau and Pomeranchuk is used to solve the kinetic equation. For the superconductor, the relative contribution of the phonon wind to the thermoelectric current increases as the temperature falls because the number of excitons drops off exponentially with decreasing temperature and the scattering of phonons decreases. In addition the acoustoelectric effect of ultrasonic vibrations is investigated. These are capable of tearing excitation pairs out of condensates. References 14: 13 Russian, 1 Western. [191-8480]

USSR

SCATTERING OF HOT EXCITATIONS WITH TRANSITIONS TO EXCITED STATES IN POLAR SEMICONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 2028-2035 manuscript received 6 Feb 79

TRALLERO GINER, K., LANG, I. G. and PAVLOV, S. T., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] In calculating the inverse lifetime of a "hot" Wannier-Mott exciton with principle quantum number n = 1, it is necessary to take into account the probabilities of scattering of the excitation with transition to an excited state. The properties of the various transitions are discussed for hot excitations in polar semiconductors with hole and electron interaction with longitudinal optical phonons predominant. The scattering

probability is formulated in terms of Fermi's "golden rule", the ground states and final states are described in terms of wave functions, the conservation laws are applied, and the resulting equations are interpreted. Simplified equations are derived for $n \gg 1$. Graphs of the scattering properties are given as functions of kinetic energy. Figures 4; references 12: 9 Russian, 3 Western.
[191-8480]

USSR

THE OFF-CENTER JAHN-TELLER ION: COUPLED POLAR AND TETRAGONAL DEFORMATION

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 2083-2090
manuscript received 19 Feb 79

VIKHNIN, V. A. and SOCHAVA, N. S., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] An attempt is made to interpret observed properties of the EPR spectra of Ni^{+} and Cu^{2+} in SrO. A model of the Ni^{+} center which does not assume an additional point defect near the Ni atom is proposed. It is possible for fourth-order anharmonism to be predominant if the polarization energy, Born-Meyer potential and Coulomb energy cancel in the third-order anharmonic equation. The fourth-order anharmonic potential equation is set up and an approximation of the adiabatic potential derived. The potential has 4 minima, each with two tetragonal deformations of different magnitude. Accordingly the symmetry of the Jahn-Teller ion is C_1, which agrees with experiment. It is shown that the tunneling probability is highest between two wells in the direction of the maximum Jahn-Teller effect deformation; maximum anisotropy of the g-factor is expected in this direction. Rising temperature results in faster transitions and accordingly broadening of lines and leveling of the spectrum, as observed experimentally. A similar analysis explains higher-temperature leveling. The approach to Cu^{2+} in SrO uses an 8-hole potential and third-order anharmonism. Thanks are expressed to Yu. N. Toplarov for discussion. References 16: 11 Russian, 5 Western.
[191-8480]

USSR

METAL-DIELECTRIC TRANSITION IN MANY-VALLEY SEMICONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 2171-2173 manuscript received 6 Feb 79

ANDRYUSHIN, YE. A., GEL'FOND, O. A. and SILIN, A. P., Physical Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The metal-dielectric transition is considered in a system of impurities in many-valley semiconductors. The critical density of the transition is defined in terms of zero binding energy of the donor, which is in turn determined by solving the Schrodinger equation for an electron in a screened Coulomb potential (static plasma screening of Coulomb interaction). The Thomas-Fermi approximation is used. For the degenerate case, numerical integration of the Schrodinger equation with screened Coulomb potential is carried out using Hubbard's approximation. A graph of calculated results for the following numbers of electron valleys is given: 1, 4 (Ge), 6 (Si), and 10 ($Ge_{0.85}Si_{0.15}$). The results agree with figures previously derived when T = 0. The temperature dependence of the critical density is increasing for 1 and 4 valleys and decreasing for 6 and 10 valleys (because in this model the temperature correction to the screening has changing sign). Similar effects are observed in P-doped silicon. Thanks are expressed to L. V. Keldysh for interest and discussion. Figures 1, references 7: 1 Russian, 6 Western.
[191-8480]

USSR

ON THE QUESTION OF EXACT SOLUTIONS IN THE THEORY OF SEMICONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 2175-2177 manuscript received 7 Feb 79

ROGOZHKIN, V. V. and VASIL'YEV, L. I., Leningrad Institute of Precision Mechanics and Optics

[Abstract] In dealing with the problem of using pure metals as semiconductors, the nonlinear Ginzburg-Landau equations are solved for a wide range of magnetic field values. It is necessary to use approximate calculation methods. But some physically nontrivial problems with exact solutions exist. The exact solution of the system of equations for the plane problem with axial symmetry when $\kappa = 1/\sqrt{2}$ is presented. This applies, for example, to pure niobium near the critical temperature. The solution is in the

form of a recursive equation. When the solution is known it is possible to calculate the deformation field created by a loop in an elastic continuum semiconductor, and the distribution of the magnetic field in the vicinity of the loop. References 4: 2 Russian, 2 Western.
[191-8480]

USSR

THE EFFECT OF SPECULAR REFLECTION ON THE POLARIZATION OF SCATTERED LIGHT IN RESONANCE EXCITATION OF EXCITONS IN CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 7, Jul 79 pp 2182-2184 manuscript received 8 Feb 79

IVCHENKO, YE. L. and YULDASHEV, N. KH., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A theoretical study is made of the polarization of radiation multiply scattered in a semibounded crystal with excitation by polarized light. Specular reflection of light exiting from the crystal is assumed, which affects its polarization. Isotropic crystals only are considered. The radiation transmission equations are formulated in terms of the Stokes parameters, which are related to the initial four-component flux and a scattering matrix. The latter adds a term for specular reflection. The Stokes parameters are calculated for normally incident exciting light, producing two independent linear integral equations and a system of three linear integral equations, which are solved by computer. A graph of the degree of linear and nonlinear polarization of light emitted "back" as a function of the albedo in stimulation by linearly and circularly polarized light is given. When there is multiple scattering the two polarizations are less than 100%. For conservative medium the linear polarization is about 32% and the circular polarization about 24% without reflection. With reflection the values are below 4% because of the limited angle at which exit is possible in semiconductors. A graph of polarizations with single and double scattering is presented. Thanks are expressed to G. Ye. Pikus and N. A. Silant'yev for discussions. Figures 1, references 5: 3 Russian, 2 Western.
[191-8480]

USSR

CONTROLLING THE TRAJECTORIES OF CHARGED PARTICLES BY USING A BENT SINGLE CRYSTAL

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 7, 5 Oct 79 pp 474-478 manuscript received 11 Aug 79

VODOP'YANOV, A. S., GOLOVATYUK, V. M., YELISHEV, A. F., IVANCHENKO, I. M., KADYROV, R. B., KARPENKO, N. N., KOREN'KOV, V. V., NIGMANOV, T. S., RYABTSOV, V. D., SENNER, A. YE., SI[illegible]R, B., STARCHENKO, B. M., SUTULIN, V. A., TYAPKIN, I. A., URAL'SKIY, E. V., FILATOVA, N. A., TSYGANOV, N. N., SHAFRANOV, M. D., Dubna, WOJTKOWSKA, I., GUZIK, Z., ZELAZNY, R., FORYCHI, A., Swierk, GRISHAYEV, I. A., KOVALENKO, G. D., SHRAMENKO, B. I., Khar'kov, BAVIZHEV, M. D., BULGAKOV, N. K., Tomsk, KARRIGAN, R., TUIG, T., Batavia, GIBSON, V. M., SAN, CH. R., IK-DZHO KIM, FELPS, DZH., New York, and AVDEYCHIKOV, V. V., Leningrad

[Abstract] It has been experimentally predicted that deformed single crystals can be used to control the trajectories of charged particles captured in channeling. This paper is a report of an experiment done to check this hypothesis on the electron linac at the Joint Institute of Nuclear Research in Dubna. It is shown that 8.4 GeV protons captured in planar channeling by a bent silicon single crystal are deflected through an angle of up to 26 mrad. The radius of curvature of the particle trajectory was about 38 cm, which corresponds to an average transverse electric field of about 240 MV/cm acting on the particle. This is the equivalent of a magnetic field with induction of about 0.82 MGs. Figures 4; reference: 1 Russian.
[59-6610]

USSR UDC 532.593+539.129

SHOCK WAVE FRONT STRUCTURE IN A LIQUID

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249, No 24, 1979 pp 840-843
manuscript received 30 Jul 79

KLIMENKO, V. YU. and DREMIN, A. N., Chernogolovka, Moscow Oblast, Institute of Chemical Physics Affiliate of the USSR Academy of Sciences

[Abstract] The shock wave front structure in a liquid was investigated by the method of molecular dynamics of equilibrium systems. In this method, a real substance is simulated by a limited number of particles (of the order of 100-1000) whose equations of motion are numerically integrated so that the coordinates and velocities of all the particles are known at any time instant, thus making it possible to compute from corresponding formulas the required macroscopic properties of the system, on using periodic boundary conditions to eliminate the effect of the walls. A cell containing 2,592 atoms of argon, simulating liquid argon, was used in the calculations. The differential equations of motion of the particles were numerically solved on a BESM-6 computer. Liquid argon with all the structural and kinetic features characteristic of its liquid form was simulated by specifying corresponding densities and temperatures of the system. The shock wave was generated by inducing a particle layer to move at mass velocity u in the x-direction so as to compress the substance so that a shock wave would propagate throughout the cell. It was found that in the shock wave the transition of matter to the compressed and heated state occurs extremely rapidly, within $\sim 10^{-12}$-10^{-13} s, which is a time period equal to that of translational relaxation. Hence equilibrium with respect to translational degrees of freedom is absent in the shock wave front. Analysis of the evolution of the molecular velocity distribution function on transition across the shock wave showed that the function is an equilibrium function, i.e. a Maxwellian function, only in front of and behind the shock wave front, whereas within the front it is markedly distorted. Hence the concept of thermodynamic temperature is not applicable to the shock wave front, and in this case only the mean kinetic energy of particles (kinetic temperature) can be considered. The width and structure of the front are similar for both strong and weak waves. Figures 3; references 9: 3 Russian, 6 Western
[67-1386]

USSR UDC 532.517.4

CALCULATION OF A TURBULENT BOUNDARY LAYER ON A PLATE WITH INTENSE BLOW-IN

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 4, Oct 79
pp 589-593 manuscript received 25 Apr 78

DYMANT, L. N. and SPANOVSKIY, V. M., Sevastopol' Instrument Making Institute

[Abstract] A theoretical analysis is made of turbulent boundary layers on a permeable plate with intense blow-in where there is no friction on the wall. The technique is based on a two-zone boundary layer model that assumes an external jet zone with a universal velocity profile, and an internal zone near the wall. By using a universal velocity profile in the external zone the authors are able to reduce the problem of boundary layer analysis to determination of the velocity profile in the inner zone and determination of the parameters of the interface between zones. The calculation utilizes integral equations of momenta for the layer as a whole, and for its internal zone. The results of the calculation are compared with experimental data and found to agree satisfactorily. Figures 3, references 19: 15 Russian, 4 Western.
[58-6610]

USSR UDC 517.9:533.7

FLOW AROUND BLUNT BODIES WITH POINTS AND DEPRESSIONS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 4, Oct 79
pp 712-716 manuscript received 29 Nov 78

DAVYDOV, YU. M., DOROBITSYN, G. P. and POSTNIKOV, V. G.

[Abstract] Even slight changes in the shape of the generatrix of solids of revolution can have a strong effect on aerodynamic drag. Singularities like points and depressions in the region of the nose section are particularly significant in this regard. The authors analyze the flow of an ideal gas around such bodies in the two-dimensional formulation. The numerical study covers velocities of the oncoming flow in a range of $0.9 \leq M_\infty \leq 7.0$. The analysis is based on the "coarse particle" technique. It is shown that the use of sharp points can reduce head drag by 30-50%, while depressions increase drag by 6-8% depending on size. Figures 2, references: 11 Russian.
[58-6610]

USSR UDC 534.23:532.528

CLOSURE OF A SPHERICAL CAVITATION BUBBLE BETWEEN TWO RIGID WALLS

Minsk IZVESTIYA AKADEMII NAUK BSSR. SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 5, 1979 pp 107-113 manuscript received 21 Dec 78

DEZHKUNOV, N. V., KUVSHINOV, G. I. and PROKHORENKO, P. P., Physico-Technical Institute, Belorussian SSR Academy of Sciences

[Abstract] Situations in which a bubble forms in between two rigid walls are fairly frequent in, e.g. ultrasonic cleaning of flat surfaces, deposition of metal coatings, impregnation, etc. In this connection, the conditions of closure of the bubble were investigated. It is shown that the presence of the second wall results in a decrease in the rate of closure of the bubble compared with bubbles forming in the neighborhood of a single wall, because the second wall impedes the influx of liquid to the bubble enclosed in between two walls. This appears to be a major reason for the decrease in the erosive effect of acoustic cavitation arising in the gap between the emitter and the surface being treated. The investigation was carried out with respect to spherical bubbles; it will be continued with respect to cavitation bubbles of other shapes. Figures 2; references 10: 9 Russian, 1 Western.
[54-1386]

USSR UDC 537.226:536.24:532.551

THE EFFECT OF AN ELECTRIC FIELD ON FLOW AND HEAT EXCHANGE OF A DIELECTRIC FLUID IN AN ANNULAR CHANNEL

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 4, Jul-Aug 79 pp 777-782 manuscript received 9 Oct 78

MAL'KOVSKIY, V. I. and MURATOVA, T. N., Power Institute imeni G. M. Krzhizhanskiy

[Abstract] The effect of an electric field on flow and heat exchange of a dielectric fluid in an annular channel is of importance to the development of cryogenic high-voltage engineering. A theoretical study is made of stationary flow of a dielectric fluid in a channel formed by two coaxial cylinders, with a constant potential difference between the walls, a heat flow through the outer wall and an adiabatic inner wall. On the basis of certain simplifying assumptions it is demonstrated that the equations of motion and energy can be solved separately for the small heat fluxes characteristic of stationary operation of a coaxial cryocable containing helium. The rate field is determined for an infinite channel. There is

a dual effect: on one hand the rate of Poiseuille flow is increased, while on the other hand the flow is slowed at the outer wall and accelerated near the inner wall. A graph of the temperature field is presented. It is found that heat transfer worsens when an electric field is applied because of slowing of the flow at the heated wall. When the wall is cooled, the flow rate along it increases and heat exchange is improved. Figures 3, references 9: 7 Russian, 2 Western.
[187-8480]

USSR

UDC 621.375.826

EXPERIMENTAL STUDY OF A GASDYNAMIC CO_2 MIXER LASER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248, No 1, 1979 pp 81-83 manuscript received 10 Jun 79

VYSKUBENKO, B. A., DEMENYUK, YE. T., KIRILLOV, G. A., KOLOBYANIN, YU. V., KORMER, S. B. and NITOCHKIN, N. A.

[Abstract] An experimental investig tion is made of the energy characteristics of a gasdynamic mixer laser with flat nozzle at a pressure of up to 50 atmospheres and a temperature of up to 3000 K. Nitrogen is heated by an electric explosion, the expanded nitrogen bursts a diaphragm and flows through a flat supersonic nozzle into the optical cavity of the laser. The nozzle is 17 cm wide and has a critical height of 0.16 cm. The nozzle has a geometric degree of expansion of 15.5. Premixed CO_2 and He are injected into the region of the critical section of the nozzle. Lasing is achieved by means of two single-pass resonator cavities in series one after the other. Maximum specific energy output was 54 J/g. Comparison with the best homogeneous gasdynamic lasers shows that the mixer laser is superior in energy characteristics. Figures 2; references 7: 5 Russian, 2 Western. [45-6610]

USSR

OBSERVATION OF COHERENT INTERACTION BETWEEN A NANOSECOND PULSE OF A CO_2 LASER AND THE AMPLIFYING MEDIUM

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 593-595 manuscript received 23 Aug 79

BARANOV, V.YU., BORZENKO, V. L., MALYUTA, D. L., PETRUSHEVICH, YU. V., SAMOV, YU. A., SEBRANT, A. YU., SMAKOVSKIY, YU. B., STAROSTIN, A. N. and STREL'TSOV, A. P.

[Abstract] Coherent effects may be of major importance to the formation of ultrashort pulses in the amplifying medium so as to obtain short tailored CO_2 laser pulses for utilization in thermonuclear research. In this connection, the first ever observation of the breakdown of a nanosecond pulse during its amplification in a CO_2 laser is now reported on. The original pulse was produced with the aid of a CO_2 atmospheric-pressure laser system, an electrooptical shutter, and an atmospheric-pressure preamplifier. A mirror system was then used to accomplish several passages of the original pulse in the CO_2 amplifier. The pulse shape was recorded with the aid of

a pyroelectric sensor. The time resolution of the oscillograph used was 0.7 ns. The oscillograms revealed a marked sharpening of the leading edge of the pulse and its separation into two "2π" pulses. These experimental findings were qualitatively-corroborated by numerical calculations based on a system of equations allowing for coherent interaction as well as for rotational and vibrational intra- and intermodal relaxation. Figures 2; references 10: 3 Russian, 7 Western.
[66-1386]

USSR

GIANT OSCILLATIONS OF THE PASSAGE OF A QUASI-SURFACE SPIN WAVE ACROSS AN YTTRIUM-IRON GARNET (YIG) THIN FILM

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 600-603 manuscript received 25 Aug 79

GLUYAYEV, YU. V., BUGAYEV, A. S., ZIL'BERMAN, P. YE., IGNAT'YEV, I. A., KONOVALOV, A. G., LUGOVSKOY, A. V., MEDNIKOV, A. M., NAM, B. P. and NIKOLAYEV, YE. I., Institute of Radio Engineering and Electronics, USSR Academy of Sciences

[Abstract] Previously predicted giant oscillations of the Daman-Eshbach coefficient of wave passage across a thin epitaxial YIG film were for the first time experimentally observed and interpreted. To this end the excitation and propagation of a quasi-surface spin wave in single-crystal YIG films were investigated. Measurements of the delay time of the microwave pulse showed that the antennas excited a Daman-Eshbach wave. The attendant giant oscillations are linked to the decay of the Daman-Eshbach wave rather than to its spectrum. This newly discovered effect is of interest since it reveals a nontrivial structure of the Daman-Eshbach wave in thin ferromagnetic films with a narrow FMR line. The existence of passage maxima should be taken into account in the ongoing attempts to observe the amplification of the Daman-Eshbach wave by the electron current in structures with an adjoining semiconductor. Figures 3; references 7: 3 Russian, 4 Western.
[66-1386]

USSR UDC 621.375

THE EFFECT OF PRESSURE ON THE FORMATION OF A POPULATION INVERSION IN A CO_2 GASDYNAMIC LASER WITH A MIXTURE OF CO + N_2O + (N_2 + He)

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 4, Jul-Aug 79 pp 717-721 manuscript received 19 Jul 78

KUDRYAVTSEV, N. N., NOVIKOV, S. S. and SVETLICHNYY, I. B., Institute of Chemical Physics, USSR Academy of Sciences, Moscow Physico-Technical Institute

[Abstract] The effect of pressure (5, 10 and 20 atmospheres) on the population inversion in a CO_2 gasdynamic laser with CO and N_2 using a shock tube and nozzle was studied. The vibration temperatures of asymmetric and symmetric vibration modes of CO_2 were measured; this gave the population of the N_{001} and N_{100} (upper and lower) laser levels and provided a measure of stimulated and spontaneous radiation. Initial proportions were 0.05 N_2O, 0.25 CO, 0.4 N_2, 0.3 He and the temperature range before the nozzle was 1,600-3,000 K. A continuous increase in the gain coefficient was observed as the pressure was increased from 5 to 20 atm, while the optimal conditions shifted toward higher temperatures. This is explained by a decreasing population in the lower laser levels. Graphs of the gain coefficient, relative population inversion, vibrational temperature of the asymmetric mode for CO_2 and vibrational temperature of the joint mode for CO_2 as functions of temperature are presented for the three pressures used. Figures 4; references 13: 8 Russian, 5 Western.
[187-8480]

USSR UDC 533.932

OPTICAL PROPERTIES OF HYDROGEN PLASMA WITH ADDITION OF POTASSIUM

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 27, No 4, Jul-Aug 79 pp 673-677 manuscript received 22 Jul 78

KUZNETSOVA, N. I. and LAPPO, G.B., Moscow

[Abstract] The addition of an alkali metal with a low ionization potential to hydrogen results in a strongly ionized plasma at 3000-5000 K. In addition to the usual potassium absorption lines, the following elementary absorption processes must be taken into account: absorption by the KH molecule (low temperature), hydrogen lines (about 10,000 K), photostripping of electron from H^-, and H_2 bands (UV). The calculation for KH is based on the Franck-Condon factors and solution of the Schrodinger equation by the Numerov numerical method. Also taken into account are IR absorption in V-R transitions of KH, and high-pressure V-R transitions in the $(H_2)_2$ quasimolecule. The spectral coefficient for quasimolecules is calculated for $\Delta j = 0 \pm 2$ in the range 2,000-10,000 cm^{-1}, and k_{abs} is calculated for various parameters (mixtures with 3, 10 and 50 mole percent of K, pressures of 1, 10, 100 and 500 x 10^5 Pa, T = 3,000-4,000 K). Correction is made for stimulated emission. A table of radiant heat conductivity coefficients is included. Figures 1; references 16: 3 Russian, 13 Western. [187-8480]

USSR UDC 621.313.522.21

SIMULATION OF NONEQUILIBRIUM PHYSICAL AND CHEMICAL PROCESSES IN SUPERSONIC FLOW OF COMBUSTION PRODUCTS IN AN OPEN-CYCLE MDH GENERATOR

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 4, Jul-Aug 79 pp 849-837 manuscript received 9 Jul 78

PRUSOVA, N. M., Siberian Power Institute, Siberian Department, USSR Academy of Sciences

[Abstract] At high flow velocities, regions of flow with nonequilibrium processes may occur in MHD generators, producing changes in composition and thermodynamic and transport properties. A model is presented of the effect of chemical and ionization nonequilibrium and nonequilibrium electron capture on the thermodynamic properties of the working medium. Simplifying assumptions are: equilibrium composition and thermodynamic properties in the critical section of the nozzle; consideration only of changes in the concentration of K^+, OH^- and e^-; no effect on temperature and pressure from

neutral components from recombination of ions. A system of kinetic equations using reaction constants for the various reactions taken into account is set up, and a procedure for numerical solution by computer outlined. Graphs of the following factors are presented: effect of the energy of affinity of OH for the electron on variation of electron density; change of mole percentages of NO and O as a function of the parameter $\overline{r}$ in the nozzle and channel; and change of electron density as a function of temperature; all for both equilibrium and nonequilibrium conditions. In addition a table of the mole percentage of CO_2 as a function of $\overline{r}$ is presented. It is found that variations in the concentrations of H_2O, CO_2 and e^- occur at speeds V greater than 1500 m/sec and for small pressures (below 1 MPa) in the combustion chamber. Thanks are expressed to Yu. G. Pirumov for help in calculations and to N. M. Pshenichnov for assistance in the work.
Figures 4; references 20: 14 Russian, 6 Western.
[187-8480]

USSR

ATOMS AND MOLECULES IN THERMAL INEQUILIBRIUM AS FACTORS IN THE BRANCHED CHAIN REACTION BETWEEN HYDROGEN AND FLUORINE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248, No 3, 1979 pp 610-613 manuscript received 14 May 79

NIKEROV, V. A., RUSANOV, V. D. and SHOLIN, G. V., Moscow, Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] The effect of the translational inequilibrium of atoms and molecules on the hydrogen-fluorine chain reaction rate and chain interaction is investigated. Examination of the [H]/[H] + [F] ratio as a function of the partial concentration of F_2 in the mixture shows that in the presence of low partial concentrations of molecular fluorine the rupture of the chain occurs on hydrogen atoms, whereas at high concentrations of that element chain rupture on fluorine atoms begins to become significant. Another important manifestation of the thermal inequilibrium of the chain-reaction products is the possibility of branching of the chain owing to the translational energy of these products. The translational inequilibrium of the products of chemical reactions apparently is a major factor in the interaction of hydrogen, deuterium, and tritium with mixtures of halogens and interhalide compounds. These findings are of interest to research into chemical lasers. Figures 3; references 14: 4 Russian, 10 Western. [48-1386]

USSR UDC 621.311.25:621.039:697.34

MATHEMATICAL MODEL OF OPTIMIZATION OF THE STRUCTURE OF ATOMIC SOURCES OF HEAT

Moscow ATOMNAYA ENERGIYA in Russian Vol 47, No 4, Oct 79 pp 241-244
manuscript received 9 Oct 78,after revision 18 Jan 79

BRAILOV, V. P., VORONKOV, M. YE. and CHAKHOVSKIY, V. M.

[Abstract] The authors discuss methods of comprehensive optimization of the structure of nuclear heat sources with consideration of systems factors (primarily indices of the external fuel cycle). One effective way to settle the problem is by using computers in the method of mathematical economic modeling. To work out forecasts in nuclear engineering, mathematical models have been developed for optimizing the structure of this branch of industry, and for determining the role of different types of reactors in power systems, the cost of plutonium and so on. Such a model is proposed for optimizing the structure of nuclear sources of heat supply with consideration of development of the nuclear industry. The optimization is based on selecting one of the possible versions of the heat supply system for each city in accordance with the global optimum in development of nuclear power engineering. The resultant model enables optimization by types of power plants and installed equipment in a systems approach with regard to the dynamics of development and interaction among different kinds of nuclear power sources. An estimate can be made of the relative effectiveness of different types of nuclear heat sources and organization of chemical processing of spent fuel. The model also provides a basis for optimizing the conversion of stations from one kind of fuel to another. Calculations based on the proposed model using preliminary initial data show that the structure of nuclear heat sources is strongly affected by the cost and available resources of natural uranium and the organization of chemical processing of spent fuel in addition to the specific capital investments in power plants of various types and local conditions. References: 4 Russian. [49-6610]

USSR UDC 621.039.5:539.12.03

FISSION PRODUCTS AS GAMMA SOURCES

Moscow ATOMNAYA ENERGIYA in Russian Vol 47, No 4, Oct 79 pp 247-253
manuscript received 25 Sep 78, after revision 29 Mar 79

STARIZNYY, YE. S., MARKINA, M. A. and CHERKASHIN, V. A.

[Abstract] A brief survey of the literature on the principal characteristics of gamma radiation of ^{235}U fission products. An analysis is made of

the capabilities of radiation facilities in which the gamma sources are completely depleted fuel elements, elements that are repeatedly transferred back and forth between the reactor core and the irradiator, and a uranium radiation loop. The authors discuss the parameters of facilities with depleted fuel elements, and with transfer of fuel elements back and forth between the reactor core and the irradiator. It is shown that a uranium radiation loop can be effectively used in industrial facilities. Figures 6, references 51: 37 Russian, 14 Western.
[49-6610]

USSR UDC 621.384.64.01

LOSSES OF PARTICLES IN A PROTON LINAC DUE TO RANDOM ERRORS OF THE PARAMETERS OF THE FOCUSING CHANNEL

Moscow ATOMNAYA ENERGIYA in Russian Vol 47, No 4, Oct 79 pp 254-258
manuscript received 2 Dec 77

OSTROUMOV, P. N. and FATEYEV, A. P.

[Abstract] In ring accelerators, particle losses due to random perturbations of motion can be found analytically by the Einstein-Fokker equation. It is shown in this paper that an analogous method can be used in linear proton accelerators as well for calculating the losses of particles due to random errors in the alignment and the parameters of the focusing elements. The solution of the problem is based on the assumption that the density of the propagated charge in the beam can be disregarded. The proposed method can be used to find the distribution of losses of particles along the accelerator, and to calculate the losses in real focusing channels. This is particularly important in the case of "meson factories" where relative losses must not exceed 10%. The results of loss calculation are given for some working linacs, and are compared with experimental data. It is concluded that manifestation of a beam "halo" may be due to random errors in the focusing channel of the accelerator. Figures 3; references 7: 6 Russian, 1 Western.
[49-6610]

USSR UDC 538.121.8

INTERACTION OF HEAVY-CURRENT RELATIVISTIC ELECTRON BEAM WITH MATTER

Moscow ATOMNAYA ENERGIYA in Russian Vol 47, No 5, 1979 pp 328-332
manuscript received 20 Nov 78

DIDENKO, A. N., CHISTYAKOV, S. A. and YALOVETS, A. P.

[Abstract] The behavior of matter interacting with heavy-current electron beams (HCEB) is known to differ from its behavior when interacting with conventional (non-intense) electron beams. While complete solution of this complex question is as yet not feasible, the problem of finding the fast electron flux in matter under HCEB is simpler, and the solution of this problem would serve to clarify the basic patterns of behavior of HCEB in matter. Accordingly this approach was adopted in conducting a numerical investigation of such interactions. It is shown that the transfer of energy to the substance of the target by the electron beam occurs not only through inelastic collisions but also through the conversion of the Coulomb energy of interaction (of fast neutrons with the field) to thermal energy upon dissipation of the space charge generating that field. It is further shown that the increase in the density of the incident current in the presence of a fixed conductivity of the medium results in a redistribution of the energy spent on the matter. In this connection, the anomalous energy absorption in thin foils upon passage of HCEB through them is tentatively attributed to the effect of the Coulomb field on the transport of fast electrons. Figures 3; references 8: 6 Russian, 2 Western.
[79-1386]

USSR UDC 539.17

CROSS SECTIONS FOR FISSION OF ^{235}U AND ^{238}U BY 14.7 MeV NEUTRONS

Moscow ATOMNAYA ENERGIYA in Russian Vol 47, No 6, Dec 79 pp 416-418
manuscript received 24 Jan 79

ALKHAZOV, I. D., DUSHIN, V. N., KOVALENKO, S. S., KOSOCHKIN, O. I., PETRZHAK, K. A., SHPAKOV, V. I.: Soviet Union, ARL'T, R., VAGNER, V., VAYDKHAZE, F., GRIMM, V., KRAUZE, R., MUZIOL', G., ORTLEPP, KH. and TAYKHNER, R., East Germany

[Abstract] Absolute measurements were done on the fission cross sections for ^{235}U and ^{238}U with fission by neutrons with energy of 14.7 MeV. The research was done jointly by Dresden Technical University and the V. G. Khlopin Radium Institute in Leningrad on the facilities and accelerator of

Dresden Technical University. The measurements were made by the technique of coincidence of fission fragments. The neutron generator used the reaction $T(d,n)^4He$ with deuteron energy of 130 keV. The fissile target was exposed to neutrons at an angle of 13° to the deuteron beam. The particle detector was a thin scintillation counter. The results of the measurements give a fission cross section of 2.073 ± 0.023 barns for ^{235}U, 1.194 ± 0.022 barns for ^{238}U and a resultant ratio of 0.576 ± 0.012 for the two isotopes. The authors thank P. Raics of Debrecen, Hungary for calculating the neutron energy under the conditions of the experiment. References 15: 2 Russian, 13 Western.
[78-6610]

USSR UDC 523.11

EXPERIMENTAL DETERMINATION OF ACCELERATION OF FREE FALL OF A RELATIVISTIC CHARGED PARTICLE. II. A CYLINDRICAL SOLENOID IN A STATIONARY FIELD OF FORCES OF INERTIA

Tomsk IZVESTIYA VUZov: FIZIKA in Russian No 8(207), 1979 pp 28-32
manuscript received 12 May 78

GONYAYEV, V.V., All-Union Scientific Research Institute of Physico-technical and Radiotechnical Measurements

[Abstract] In the first part of this research [Izv. vuzov: fizika, No 4, 1977, p 7] the author formulated the problem of motion of a relativistic charged particle in a constant homogeneous magnetic field under the action of stationary forces of inertia defined by the vectors $\vec{W}$, $\vec{a}$ = const. It is pointed out that the electromagnetic field is influenced by inertial forces, which must be taken into consideration in calculating the electric and magnetic fields that arise in a long cylindrical solenoid. Taking the radius-vector of the particle as very small compared with the radius of the earth, $\vec{W}$ and $\vec{a}$ can be considered small parameters and applied in the linear approximation to the problem of finding the general-relativity correction to the electromagnetic field. The method is used to determine the acceleration of free fall of a relativistic charged particle in an arbitrarily oriented infinite cylindrical solenoid at rest in a steady-state field of intertial forces. It is shown that an electric field associated with the angular rate of rotation of the local coordinate system arises inside and outside of the solenoid. References 7: 5 Russian, 2 Western.
[60-6610]

USSR

UDC 530.12:531.51

A NEW SOLUTION OF THE EINSTEIN-DIRAC EQUATIONS

Tomsk IZVESTIYA VUZov: FIZIKA in Russian No 8(207), 1979 pp 91-95
manuscript received, 20 Jun 78, after revision 29 Jan 79

GUTS, A. K., Omsk State University

[Abstract] The author considers the dynamics of self-gravitating spinor matter within the framework of general relativity theory as described by the Einstein-Dirac equations. A study of the solution of these equations will in time answer the questions of whether a broader notion of the structure of matter with consideration of internal degrees of freedom (spin) of a medium will alter the problem of singularities, and whether it is possible to geometrize neutrino fields in the Wheeler-Raynich sense. In connection with these questions the derivation of special solutions of these equations is examined, in particular the problem of gravitational radiation of neutrino flux. It is assumed that the neutrino field is planar and propagates in the positive direction of the x-axis, and that the gravity field it produces is a wave field. References 8: 6 Russian, 2 Western.
[60-6610]

USSR

GENERATION OF HEAVY IONS WITH Z > 20

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 8, 20 Oct 79 pp 489-491

BYKOVSKIY, YU. A., LAGODA, V. B. and SHEROZIYA, G. A., Moscow Institute of Engineering Physics

[Abstract] An experimental study was made to analyze the fission products in hot plasma spots of a plasma diode. For this purpose, a low-inductance capacitor across a pair of pure-metal electrodes was placed in a vacuum chamber. Discharge was initiated with a laser pulse focusing on one of the electrodes and the discharge current was allowed to reach 100 kA after 1.5 μs. An analysis of the ion signal spectrum and energy distribution has revealed an emission of heavy particles with M > 100 and Z > 20 (Sn^{+21}, Ta^{+22}, W^{+23}, Pb^{+25}, Bi^{+25}), their ionicity increasing with their mass, which explains the more efficient ionization during slowdown of plasma dissipation and indicates a "quenching" of ions during fission of hot plasma spots in a noninductive discharge without recombination during dissipation of a plasma cluster in vacuum. The authors thank V. L. KANTSYREV for helping with the experiments. Figures 3; references 3: 1 Russian, 2 Western.
[64-2415]

USSR

INDUCED CAPTURE OF A NEUTRON BY NUCLEI IN A LASER RADIATION FIELD

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 8, 20 Oct 79 pp 541-545 manuscript received 2 Jun 79

ZARETSKIY, D. F. and LOMONOSOV, V. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Negative p-levels below but close to the neutron bond energy in compound nuclei can be examined by a method involving the use of an external laser field. With the aid of the wave function of atoms in the saturation state, and with retardation disregarded, an expression for the intensity of the high-frequency electric field at the nucleus is derived from an expression describing the charge density and the transition current in the atom due to that field. Considering the entrapment of thermal neutrons at a negative p-level, in this case induced by the high-frequency internal field of the atom, the cross section for resulting nuclear reactions is then calculated on the basis of the interaction Hamiltonian pertaining to a neutron in the laser-induced high-frequency field and with the Fourier transform of a nuclear reaction. This cross section is subsequently averaged over the initial neutron energy distribution, with the integral easily evaluated in the cases of resonance or far from resonance. References: 3 Russian.
[64-2415]

USSR

DIFFERENTIAL SPECTRUM OF CONVERSION ELECTRONS AND EXCITATION ENERGY OF THE $(1/2^+)$ ISOMER OF URANIUM-235

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 8, 20 Oct 79 pp 549-553 manuscript received 21 Aug 79

ZHUDOV, V. I., ZELENKOV, A. G., KULAKOV, V. M., MOSTOVOY, V. I. and ODINOV, B. V.

[Abstract] The differential spectrum of U^{235m} conversion electrons was measured for the first time, with a Hewlett-Packard HP5950A ESCA spectrometer, in a study of the nuclear conversion of an E3-transition at the outer electron shells of a uranium atom generally and the decay of the $(\frac{1}{2}^+)$ U^{235m} isomer to $(7/2^-)$ U^{235}. Alpha decay of a plutonium-239 specimen served as the source of uranium isomer atoms, the latter was collected electrostatically in a pure helium atmosphere, and a layer of polycrystalline UF_4 on gold foil served as the matrix whose photoelectron spectrum

under exposure to x-radiation was also measured concurrently for identification of peaks. The difference between kinetic energies of conversion electrons and photoelectrons respectively was found to be 1409.8±0.5 eV, making the energy of isomeric $(1/2^+) \rightarrow (7/2^-)$ transition of uranium-235 equal to 76.8±0.5 eV. The authors thank A. I. LEONOV, and V. M. SHATINSKIY for helping with the work, also D. P. GRECHUKHIN, A. A. SOLDATOV and YU. A. TETERIN for the useful comments made during the discussion of the results. Figures 2; references: 10 Western.
[64-2415]

USSR

USE OF A HEAVY-CURRENT RELATIVISTIC ELECTRON BEAM TO ACHIEVE STRUCTURAL AND CHEMICAL TRANSFORMATIONS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 611-613 manuscript received 10 Sep 79

BATSANOV, S., DEMIDOV, B. A. and RUDAKOV, D. I.

[Abstract] Self-focusing of the relativistic electron beam (REB) in the diode in modern pulsed heavy-current accelerators results in a power density of $> 10^{12}$ watt/cm^2 at the focal spot at the anode. The energy release accompanying such a high current density results in the thermal explosion of the anode surface. The vapors of the investigated substance, propagating at high velocities, carry a considerable momentum which causes the appearance of powerful shock waves in the investigated substance. Considering that the attendant pressure P of the plasmoid forming at the focal spot may reach high values such as 2.5 millibar, as corroborated by metallographic analysis of copper targets exposed to the REB, boron nitride and graphite were experimentally placed at the focal spot of the accelerator, and it was found that then hexagonal BN and graphite undergo partial ($\lesssim 10\%$) transformation into fine-disperse diamond phase. In addition, the combined effect of high pressures and temperatures may be extremely promising to chemical synthesis. The REB-induced reaction $CuBr_2 + Cu \rightarrow CuBr$ was 100% successful. REB can be used to readily obtain carbides of copper and iron without the usual prolonged heating. But it appears that the most promising use of this method will be in achieving chemical interactions whose initiation requires overcoming high potential barriers (activation energies). Figures 2; references 7: 6 Russian, 1 Western.
[66-1386]

USSR

PRELIMINARY FINDINGS ON DEEP INELASTIC ANTINEUTRINO-NUCLEON INTERACTIONS WITH 2-25 GeV ENERGIES IN THE SKAT BUBBLE CHAMBER

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 627-630 manuscript received 24 Sep 79

KORABLEV, V. M., KOROTKOV, V. A., KUZNETSOV, YE. P., MAKEYEV, V. V., NIKITIN, YU. P., POLYARUSH, A. YU., SOKOLOV, A. A., SMINROV, YU. I., BARANOV, D. S., IVANILOV, A. A. and KONYUSHKO, V. I.

[Abstract] The experiment was carried out in the CF_3Br-filled SKAT bubble chamber exposed to an antineutrino beam at Institute of High Energy Physics. The total photographed interior of the chamber was 6.5 cu m, and 55,000 photographs were analyzed. The candidates for deep inelastic interaction $\tilde{\nu}_u + N \rightarrow u^+ + \chi$ were selected on the basis of several criteria. The findings on the y-distribution ($y = \nu / E_{\tilde{\nu}}$, where $\nu = E_h$ = the corrected energy transmitted to the hadrons) were found to be in agreement with the predictions of the elementary quark-parton model, within the 2-25 GeV energy range. The energy dependence of the mean square of the transmitted 4-momentum was found to be $\langle q^2 \rangle = (0.14 \pm 0.12) + (0.13 \pm 0.02)E_{\tilde{\nu}}$. Figures 3; references 6: 2 Russian, 4 Western.
[66-1386]

USSR

FIVE-MINUTE FLUCTUATIONS IN THE INTENSITY OF ATMOSPHERIC HARD GAMMA RADIATION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 631-633 manuscript received 28 Sep 79

GAL'PER, A. M., KIRILLOV-UGRYUMOV, V. G., KUROCHKIN, A. V., LEYKOV, N. F. and LUCHKOV, B. I.

[Abstract] This work is a continuation of an earlier investigation resulting in the detection of quasiperiodic 10-40 min fluctuations in the intensity of gamma radiation in the upper layers of the atmosphere, with the difference that now the volume of the experiments and the investigated frequency range were expanded. Gamma radiation was recorded with the aid of a high-altitude balloon-borne spark-chamber γ-telescope during 5 flights performed between the years 1972 and 1979 at residual-atmosphere altitudes equivalent to 4-10 g/cm^2. The duration of measurements during individual

flights ranged from 5 to 12 hr. The level of fluctuations in gamma radiation was estimated as a function of the integral spectral density J. Averaging of the findings resulted in a reliable isolation of a $\sim$5 min period of fluctuations in the intensity of atmospheric γ-quanta (with energies of $>$ 40 MeV); this period also happens to be characteristic of large-scale solar-surface oscillations, which points to a genetic relationship between 5-min fluctuations in the intensity of atmospheric γ-radiation and the processes occurring on the sun. While the mechanism of the transmission of these oscillations from the sun to the earth remains unclear, it is noteworthy that the flight on 5 July 1976, in a period of low solar activity, did not record the presence of fluctuations in γ-radiation. Figure 1; references 10: 5 Russian, 5 Western.
[66-1386]

USSR

A NEW METHOD OF PRODUCING HIGHLY ORIENTED LIGHT BEAMS BY WAVEFRONT REVERSAL

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 8, 20 Oct 79 pp 520-523 manuscript received 8 Sep 79

ANDREYEV, N. F., BESPALOV, V. I., KISELEV, A. M., MATVEYEV, A. Z., PASMANIK, G. A., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] A method of producing optical radiation with a plane wave front without the aid of a reference wave is proposed, as a means of conversion from multimodal to unimodal radiation, namely by summing the frequencies of two multimodal light beams with complex-conjugate fields. The phase of a light beam can be inverted through wavefront reversal during Mandel'shtam-Brillouin stimulated scattering, with only the space-variable part of the phase reversing the sign and the time-variable part of the phase remaining the same. A flat mirror and a Mandel'shtam-Brillouin mirror are needed for compensation of spatial distortions in the wavefront without compensating the phase changes in time. The feasibility of this method was demonstrated in an experiment with a neodymium laser (λ = 1.06 μm), also a diverging lens (F = -1 m), a splitting mirror (R = 0.10) and a doubling crystal ($LiIO_3$). It was found possible to decrease the beam divergence and to increase the spectral brightness, relative to independent doubling of the two beams into which the original beam had been split, without violating the second law of thermodynamics. The authors thank A. V. GAPONOV for discussing the results, YU. K. VEREVKIN for helping with the experiment, and M. S. SANDLER for the stimulating comments on the problem of frequency stabilization by means of complex-conjugate signals. Figures 2; references: 10 Russian.
[64-2415]

USSR

HYPER-RAMAN RESONANT SCATTERING OF LIGHT ON OPTICAL PHONONS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 9, 5 Nov 79 pp 617-620 manuscript received 24 Sep 79

POLIVANOV, YU. N. and SAYAKHOV, R. SH.

[Abstract] The first experimental observation of resonant hyper-Raman scattering (HRS) of light on optical phonons is reported on. The scattering was excited with the aid of a Nd-doped YAG laser (λ_l = 1.064 μm), and the scattered light was recorded with the aid of a strobed and cooled

photomultiplier. HRS was observed at an angle of 90° to the propagation direction of the exciting radiation, and isolated with the aid of an MDR-2 monochromator. A CdS crystal was selected as the object of investigation, since then, when a YAG laser is used to excite HRS, the scattering frequency of light lies in a near-resonance region and the resonance conditions can be modified by altering the specimen temperature. Resonant HRS was investigated by measuring the integral intensities of both the Stokes and the anti-Stokes components of the scattering on longitudinal optical phonons with E_1 (ν_{LO} = 307 cm^{-1}) symmetry. Compared with conventional combination scattering of light by CdS crystals, the hyper-Raman resonant scattering of the same crystals displays certain distinctive features. E. g. resonant HRS lines are absent for transverse phonons. Figures 2; references 7: 3 Russian, 4 Western.
[66-1386]

USSR

POSSIBILITY OF SIMULTANEOUS SELF-FOCUSING OF AN ATOM BEAM AND A LIGHT BEAM

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30, No 10, 20 Nov 79 pp 645-647 manuscript received 20 Jul 79 after revision, 12 Oct 79

KLIMONTOVICH, YU. L. and LUZGIN, S. N., Moscow State University imeni M. V. Lomonosov

[Abstract] Coaxial atom and light beams are considered with dipole forces of light pressure acting during the polarization relaxation time. With saturation taken into account, it is theoretically possible for these forces to cause simultaneous self-focusing of the atoms with the minimum electric potential at the axis and the light with the maximum refractive index at the axis. This is demonstrated numerically in the case of sodium vapor and light filling a cylinder, by calculating the atom beam concentration necessary for a self-channeling of the light (angle of diffractive divergence equal to angle of total reflection). Both beams may propagate in the same or in opposite directions, simultaneous self-focusing in the latter case being more likely with a symmetrized distribution of field and atoms.
[65-2415]

USSR UDC 539.376

INVESTIGATION OF STRESS-RUPTURE STRENGTH AND LONGEVITY OF GLASS-PLASTIC COMPOSITES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248, No 3, 1979
pp 565-567 manuscript received 3 Mar 78

ROGINSKIY, S. L. and KANOVICH, M. Z., Kryukovo, Moskovskaya Oblast, All-Union Scientific Research Institute of Glass Plastics and Glass Fibers

[Abstract] The problem of predicting the stress-rupture strength of glass-plastic composites on the basis of known short-time flexural-strength characteristics of the reinforcing filler and binder, rheological constants of the composite, and the deformation limit of the composite, is considered. It is assumed that rupture of the composite occurs under the same limiting strain regardless of the duration of loading. On this basis, a formula for determining the longevity and stress-rupture strength of the composite is derived. The presented solution is of definite interest, since normally stress-rupture strength is evaluated on the basis of costly and laborious years-long experiments. At the same time, however, the findings are not sufficiently universal, being applicable only to the composites in question. References 8: 6 Russian, 2 Western.
[48-1386]

USSR

UDC 537.312.62

INFLUENCE THAT THE TRANSVERSE RESISTANCE OF A MULTIPLE-STRAND SUPERCONDUCTIVE WIRE HAS ON ITS CURRENT-VOLTAGE CHARACTERISTIC

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248, No 1, 1979 pp 97-101
manuscript received 4 Jun 79

DOROFEYEV, G. L. and KLIMENKO, YE. YU., Institute of Atomic Energy imeni I. V. Kurchatov, Moscow

[Abstract] Modern superconductive wires for windings frequently use matrices with increased resistance in a technique that involves production of multiple-fiber wires by solid-phase diffusion in an effort to reduce energy dissipation in the wire in a variable magnetic field. Because of the increased transverse resistance of such wires, the cross sectional current distribution remains nonuniform to a considerable distance from a current contact. It is shown in this paper that the exponential nature of the current-voltage characteristic of actual rigid superconductors leads to steps on the current-voltage curves of the wires with a slope and height that depends on the characteristics of normal layers and the superconductor. The analysis is based on the simplest case of a wire with two identical superconductive layers separated by a layer of normal metal with given linear resistance. Expressions are proposed for determining the resistance of transition layers. The initial and final exponential sections of the current-voltage characteristic enable description of the current-carrying capacity of the first superconductive layer and of the wire as a whole. The authors thank N. A. Chernoplekov for interest in the work. Figures 2, references 9: 7 Russian, 2 Western.
[45-6610]

USSR UDC 551.463

A COMPREHENSIVE STUDY OF THE FLUCTUATION THERMOHYDRODYNAMIC CHARACTERISTICS OF SEA WATER

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 4, Oct 79 pp 589-593 manuscript received 13 Dec 78

BARKOV, YU. D., ISAYEV, S. V., OSTANIN, O. N., KRYLOVICH, V. I., POPOV, V. K., SOLODUKHIN, A. D. and STEPANOV, S. I., Institute of Heat and Mass Exchange imeni A. V. Lykov, Academy of Sciences BSSR, Division of the Physics and Nondestructive Testing, Academy of Sciences BSSR. Belorussian Polytechnical Institute, Minsk

[Abstract] This work was done in cooperation with the Far Eastern Scientific Research Hydrometeorological Institute as part of a comprehensive study of the pulsation characteristics of sea water based on acoustic, optical and thermocontact methods developed at the Institute of Heat and Mass Exchange imeni A. V. Lykov. These techniques are described, and block diagrams are given of the instrumentation used for studying the fluctuation characteristics of temperature, density and the index of refraction of sea water. The practical applicability of the procedures is illustrated by the results of experiments done during the 1976-1977 expedition to the coastal area of the Sea of Japan. Analysis of the results of measurements shows that pulsations in the density of sea water at given depths occur chiefly due to temperature fluctuations. Figures 4; references: 10 Russian. [58-6610]

USSR UDC 536.24.02

TEMPERATURE FIELD OF A ROTATING HOLLOW CYLINDER

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 4, Oct 79 pp 705-711 manuscript received 30 Jan 79

IGNASHOV, I. A. and BYSTROUMOV, V. A., Vologda Polytechnical Institute

[Abstract] The authors consider an infinitely long cylinder with a radial cross section that is a doubly connected region bounded on the outside and the inside by circles of fixed radius. A certain part of the outer surface of the cylinder is in contact with a strip of hot metal moving translationally at a fixed velocity so that the cylinder rotates about a stationary axis. The cylinder realizes heat perception by contact, convective and radiant heat exchange. At the instant corresponding to time zero of the heat process, a fluid is admitted to the inner channel of the cylinder in

turbulent flow to keep the temperature constant on the inside surface. The initial temperature on the outer surface is established instantaneously, and does not change with time with respect to a coordinate system fixed at the contact point and the axis of the cylinder. The initial temperature in the body of the cylinder is taken as constant. The temperature distribution in the cylinder is found for any elapsed time. The boundary conditions and heat conduction equations are given in Euler variables, which yields a solution in the physical sense of temperature (a real scalar function). A transition to Lagrange variables (change in temperature of a fixed material fiber) is realized by the appropriate substitution of variables. Figures 2, references: 5 Russian.
[58-6610]

USSR UDC 536.3

A NUMERICAL METHOD OF REFINED CALCULATION OF RE-RADIATION AND SCATTERING IN PROCESSES OF RADIATIVE HEAT EXCHANGE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 4, Oct 79 p 751
manuscript received 13 Feb 79, abstract received 25 Apr 79

ZHURAVLEV, YU. A.

[Abstract of deposited article, All-Union Institute of Scientific and Technical Information, No 2099 Dep.]

[Abstract] An examination is made of problems of calculating the resolving geometrical optics characteristics of radiation with regard to the error of the relative values of re-radiated and scattered energy under optically homogeneous and optically nonhomogeneous conditions. An approximate system of linear algebraic equations is derived that provides the required accuracy of determination of the re-radiated and scattered part of the radiation. Another system of algebraic equations is proposed for direct calculation of re-radiation and scattering in multizonal systems.
[58-6610]

USSR UDC 537.525.1

A THERMOCOUPLE IN A NONEQUILIBRIUM PLASMA

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 4, Jul-Aug 79 pp 828-834 manuscript received 10 Jul 78

IVANOV, YU. A., LEBEDEV, YU. A. and TROFIMOV, V. N., Institute of Petrochemical Synthesis, USSR Academy of Sciences

[Abstract] The nature of perturbation of a plasma resulting from introduction of a thermocouple into it for measurements is considered. The following factors are taken into account: change of the radial distribution of heat sources; heat removal by the probe; removal of charged particles by the probe; removal of excited particles by the probe; chemical reactions on the probe surface; disturbance of electric field structure by the probe. Calculations were made for a nonequilibrium plasma from the positive column of a sticking DC current discharge in the diffusion mode; Schottky's approximate theory of the positive column was used. First the radial distribution of electrons was found for different ratios of the discharge tube radius to the probe radius (probe inserted coaxially), after which the radial distribution of gas temperature was determined. A graph of the results is presented for different radius ratios. A more accurate method of determining plasma parameters is the use of two thermocouples of different diameters. An experiment was carried out using thermocouples of diameters 0.065 and 0.03 cm in a glass tube 30 mm in diameter containing nitrogen at a pressure of 1.6 mm Hg and with a discharge current of 0.01-0.075 A. A table of experimental results is presented. Thanks are expressed to D. I. Slovetskiy and A. D. Urbas for experimental data and advice. Figures 4; references 12: 6 Russian, 6 Western.
[187-8480]

USSR UDC 536.24

APPROXIMATE CALCULATION OF WALL TEMPERATURE DURING TURBULENT HEAT EXCHANGE IN A CIRCULAR TUBE WITH THERMAL BOUNDARY CONDITIONS VARIABLE OVER THE PERIMETER

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 4, Jul-Aug 79 p 878 received 19 Dec 77 (No 1383-79, Dep. 19 Apr 79, VINITI)

KHRABENSKIY, V. B., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] The hypothesis of the universality of dimensionless temperature profiles of a coolant normal to the perimeter of a channel is used to derive a simple approximate analytical formula for calculating heat exchange

in turbulent flow of a coolant in a circular tube with heat flux non-uniformly distributed over the outer perimeter. The distribution of the heat transfer coefficient and the interior wall temperature along the perimeter of the tube can be determined by the use of the formula. The method gave good results when compared with both experimental data and calculation results from a more complex method. References: 1 Russian.
[187-8480]

CSO: 1862 - END -

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PHYSICS AND MATHEMATICS

No. 61

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USSR REPORT

PHYSICS AND MATHEMATICS

No. 61

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SYNTHETIC 'RUBY' DEVELOPED FOR LASER RESEARCH

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 19 Dec 79 p 2

[Article by G. Alova: "The Heart of a Laser"]

[Text] In the Precious Stones Section of the State Historical Museum there is kept under glass a red rose of such beauty that it is difficult to tear one's eyes away from it. It looks as if it is alive, although it is made of that stone that we normally name "ruby." The synthetic version of this stone may not be as valuable to jewelers, but in the Museum of the History of Science and Technology it would surely occupy one of the most honored places, for it was in just such a synthetic ruby crystal that the famous laser beam was born.

Thus, to the ruby belongs the glory of being the best material for solid-state lasers. Only specialists knew that it owes this glory not so much to its own structure as to the admixtures of chromium ions. They are what converted a colorless corundum crystal into a blood-red ruby. After being "pumped" with energy, they emit the unique laser beam. They are also related to one of the main shortcomings of the ruby laser: it creates pulsed radiation, in the form of short bursts.

"Even today no one intends to write the ruby off," says the person I am interviewing, laboratory supervisor and Doctor of Physical and Mathematical Sciences V. Osiko, "but the palm of its superiority soon passed to another manmade material -- the garnet. In the garnet, neodymium replaces chromium as the working admixture. Because of this, lasers have acquired the desired property -- they have become generators of continuous emissions. And everything would have been all right if garnet were not so expensive. For example, in the United States a laser rod made of garnet that measures 6 by 75 millimeters costs about 1,000 dollars. . ."

Since the heart of the matter is the neodymium ions, why not try to introduce them into some other cheaper crystal? Researchers in many laboratories throughout the world have asked themselves this question. This includes the workers in the Solid-State Physics Laboratory of the USSR Academy of Sciences' Institute of Physics imeni P.N. Lebedev. When it was discovered that such crystals do not exist "in nature" and it is necessary to

synthesize them specially, the scientists' thoughts reached even further: why is it even necessary to use a crystal? Why not some well known optical material, such as glass?

Audacity? If one looks "behind the scenes" of the problem, that is the only word that is appropriate. In the garnet laser, the crystal itself serves only as a matrix, or rigid framework, that holds the neodymium ions at certain points. That is the key: at certain points. If the ions were closer together, they would simply share the accumulated energy with their neighbors and convert it to heat. There would be no emissions.

From this viewpoint, amorphous glass was a material that was known to be unsuitable. There is no crystal lattice in it. Therefore, the neodymium ions could be arranged any which way, including close to each other. Why, then, did the scientists choose glass?

"To some extent this decision was forced on us," answers Vyacheslav Vasil'yevich. "Actually, we had to create lasers for optical electronics. In other words, they had to be as small as possible. . ."

Modern computers operate at fantastic speeds. However, scientists think that the operating speed could be much higher if the "slow" electronic impulses in information exchange devices were placed with a high-speed light beam. Miniature lasers with a high energy output are also needed for these devices. How are they to be created?

One of the possible solutions to the problem is to introduce as many neodymium ions as possible into the laser rod. However, the very structure of crystals rebels against this: in them, as in a metropolitan hotel, there are always very few free places that are "reserved" for admixtures. Here the advantage of glass is revealed: it is ready to accept a practically unlimited number of "lodgers" in the form of neodymium ions. However, in order that they not interact and damp the emissions, it was necessary to isolate them from each other in some way. In order to do this, it is necessary to make glass resemble a crystal to some degree.

So the physicists cooked glass, adding different components to it. These components included phosphoric anhydride. Experiment followed experiment, but no one could catch the firebird of success. Perhaps it was only the thought that a glass-phosphate laser rod would be ten times cheaper than a garnet one that compelled the scientists to continue their search. Their patience and persistence were generously repaid: when an excessive amount of phosphoric anhydride was introduced into the glass, its structure underwent substantial changes.

"Now a unique type of partition consisting of phosphorus-oxygen chains appeared in the glass, and these partitions reliably isolated the neodymium ions from each other," relates a scientist. "Moreover, the chromium that had also been added to the glass began to act like a 'neighbor' and supplied additional energy to the ions. And so, miniature lasers with glass

cores, destined for use in integral optics and communication systems, were finally developed! At the same time, their efficiency was triple that of garnet lasers!"

At first the scientists thought that the ultraphosphate neodymium glass they had created was suitable only for producing rods for miniature lasers. However, they soon discovered that large castings of this material also compete successfully with garnet. And, summing up the results of this work, Academician A. Prokhorov emphasized that it is opening up new possibilities for both the miniaturization of optical electronic systems and improving the energy parameters of lasers.
[77-11746]

11746
CSO: 1862

MOLECULAR PHYSICS

INITIAL RESEARCH ON ANIONIC GLASS REVIEWED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 26 Dec 75 p 4

[Article by special correspondent G. Lomanov, "Unexpected in the Usual Run of Things"]

[Text] They entered the room excited, smiling, somewhat aloof: their discovery had just been recorded at a board session of the USSR State Committee on Inventions. In their thoughts they were both still there, in the hall. Yevstrop'yev rolled the charts into a tight cylinder; Petrovskiy put the samples into a briefcase. For a moment, he held a suspended square of massive, perfectly polished glass, then he handed it to me:

"Take it; add it to your collection."

An almost identical prism has been lying on my desk for a year and a half--a rememberance of a meeting at the Flight Control Center. At that time, the crew of the "Salyut-6" had been the first to initiate in-orbit experiments on obtaining optical glass under weightless conditions. Guriy Timofeyevich Petrovskiy, member-correspondent of the USSR Academy of Sciences, was their science instructor. Somehow, while relating the work of the cosmonauts, he got carried away. We listened to a genuine ode in honor of the glass--a material that was, it seemed, very commonplace.

Since that time, I have kept this souvenir prism. It didn't let me forget an old truth--the only interesting person is one who is enthusiastic about his work.

And now here is another prism. Maybe the play of light on its crystal faces will someday remind me--discoveries only come to enthusiastic people.

We have become accustomed to the classical scheme: a discovery is a flash, a fortuitous instant of illumination. Why, of course, we remember from school the exclamation of Archimedes, "Eureka!."

"Well, no," smiles Konstantin Konstantinovich Yevstrop'yev. "That only happens in the movies: you sit, think it over and, hurray, it dawns on you!

In order to do something worthwhile in science, you need years and years of work. At least we had the years."

Twenty years ago, the young candidate of sciences, G. T. Petrovskiy, went to work at the GOI--The State Optical Institute imeni S. I. Vavilov. He studied fluoride glasses. In contrast to ordinary glass, it is derived not from silica, but from beryllium fluoride. It must be noted that a few people were working with it--enthusiasts, primarily. Fluorides are generally toxic, and beryllium fluoride is particularly so. In the performance of his duties, G. T. Petrovskiy had to investigate the optical characteristics of these glasses and he, in addition to the program, studied also their electrical conductivity. He then noticed an entirely unexpected mechanism.

We must here digress slightly. Glass is essentially an insulator. However, although very weakly, it still does conduct an electric current. As early as the beginning of the century, it had been established that all processes of transmitting electricity through glass entailed the displacement within the glass of positive metallic ions--cations. The scientists of the Physical-Technical Institute imeni A. F. Ioffe then explained: within the glass there is another type of "transport" for electrical charges--electrons. That is all. Other mechanisms were simply considered to be impossible.

Why? There are also, you see, anions in glass--negatively charged atoms of oxygen, fluorine and chlorine. The fact of the matter is that anions are gigantic in comparison with the cations in metal (experts will forgive me for taking these liberties!). The anions are so much larger that one might boldly say that it is the anions that form the "framework" of a substance. You can think that they travel through the mass of glass, carrying the electrical charges with them. It does not matter how you put it, whether you say the train left or the station did. In 1961, G. T. Petrovskiy, together with his colleagues, published a paper in which they put forth the supposition that it is the anions that travel in the glass.

A week ago, when the discovery was recorded, this paper had been mentioned as a priority. It had been, however, a very long way from there to "Eureka!."

The supposition was essentially a hypothesis. What was it in reality? Guriy Timofeyevich decided to test it and turned to K. K. Yevstrop'yev.

"We were friends, both in science and in general," recalls Konstantin Konstantinovich.

I liked that well-turned phrase. Not confederates, not colleagues, but friends in science. K. K. Yevstrop'yev was one of the authors of the method which allows us to determine the nature of the particles that carry the electrical current. Together they studied G. T. Petrovskiy's glasses and the supposition proved to be correct. They published a paper which figured s a second priority in the recording of the discovery. At the time, however, neither of them thought that they had made a discovery.

The normal work went on, and in a few years the scientists studied about twenty various vitreous systems. They also contemplated curious methods of practical application of the phenomenon they studied.

Here, for example, is one of the problems. In order to obtain a material with high electrical resistance, they had previously gone about it simply--they took glass with a low concentration of cations. It was quite clear: when the transporting units in the glass are few, it means that it is more difficult for the electrical charges to make their way through the glass. However, the fewer the cations the higher the melting point of the glass and the lower the coefficient of thermal expansion--these parameters are mutually linked. In equipment, it is frequently necessary for glass to bond to metals whose coefficient of thermal expansion varies within very great limits. Sometimes it was difficult to select the necessary pair. Anionic glasses make it possible to control electrical conductivity without changing other parameters. They are not dependent upon the concentration of anions.

The new type of glass is even suited for metallurgy. Now, in order to protect metal, it is covered with a thin layer of glass. The billet is excellently preserved, but if it is struck hard enough just before it is to be worked, the covering crumbles into pieces. The method is well-known, but it is preferable to use anionic glasses-- they behave very effectively compared to an imperfect coating of metal. This is why a jacket "cut" from them protects more effectively.

One of professor K. K. Yevstrop'yev's co-workers was defending his own dissertation. Guriy Timofeyevich listened to those who spoke, and a thought occurred to him more and more persistently--how much had physical chemistry's whole system of opinions about vitreous states changed in these last years. In just this narrow field, things had changed fundamentally. In essence, a discovery had been made. He told this to his coauthor.

"Honestly speaking, I regarded it sceptically," recalls K. K. Yevstrop'yev. "It is not easy to say whether it is a discovery. Take those people who have discovered a new element or an elementary particle--they have their synchrophasatron, that sort of thing. And here we are with our pieces of glass. No, this is, of course, a joke. Seriously speaking, we feared the

requirement that the discovery introduce fundamental changes in the notions about the surrounding reality. What if our changes are not fundamental?"

They were disturbed by something else, too. This would be the first discovery in the 150-year existence of the Technological Institute imeni Lensovet, where K. K. Yevstrop'yev worked. The first person is always worried. G. T. Petrovskiy had his doubts, too. At the State Optical Institute, on the other hand, several such had already been recorded. One day their claim would appear against this background. Well then, they both had to speak at scientific councils.

"But we are scientists, not some kind of Djigits [trick horsemen]," they laugh. "We didn't wish to become the talk of the town. There are the two men who, they say, tried to discover something, go ask them how it is done."

They received positive replies from dozens of leading institutes, and related their work to colleagues in Tbilisi, Minsk, Moscow and Yerevan. Honsetly speaking, they literally placed themselves under their critics' fire. Finally, the doubts fell away when such famous scientists as Yu. A. Ovchinnikov, N. N. Semënov, N. M. Zhavoronkov and N. M. Emanuel' voted unanimously for them at a section of the presidium of the USSR Academy of Sciences.

Years of labor, years of doubt. How does one fit them into the classic scheme of discovery: you sat, pondered, then cried out,"I found it!" No, it does not happen that way.
[85-9512]

9512
CSO: 1862

APPLICATIONS OF FERROMAGNETIC LIQUIDS DISCUSSED

Moscow PRAVDA in Russian 16 Dec 79 p 3

[Article by V. Gerasimov, PRAVDA special correspondent, Leningrad: "Miracles in a Beaker"]

[Text] The experiment quickly reached its climax. Into a beaker containing a dark, oil liquid, Junior Scientific Worker Nikolay Gribanov dropped a three-kopeck piece. As would be expected because of the laws of physics, it sank. But after a minute -- contrary to those same laws -- it rose to the surface. This was the result of Gribanov's bringing a magnet into contact with the bottom of the beaker.

"That is one of the properties inherent in the liquid that has been poured into the container," he explained. "When acted upon by a magnetic field, it expels 'foreign' bodies."

The next experiment was no less marvelous and simple. Vladimir Shumilov, a staff member in the Department of Colloid Chemistry at the Technological Institute imeni Lensovet, proposed to stir the contents of another beaker with a knife.

At first the knife did not encounter any resistance, but when a magnetic field was brought near the beaker it was as if it had encountered an obstacle. Before our very eyes, the liquid became viscous. As soon as the magnetic field was turned off, the knife again began to clink merrily against the glass.

"The unusual properties of the so-called ferromagnetic liquids can be demonstrated at great length," comments the head of the department, Professor I.S. Lavrov. "Actually, they are prepared on the basis of water, kerosene, oils, mercury and metal melts. Very fine particles of iron, ferrites and other ferromagnetic substances are 'dissolved' in them. If we multiply the possible number of components among themselves and then consider the difference in the 'behavior' of the same liquid when the magnetic field is altered, we obtain a long series of interesting qualities that can be used very profitably in science and technology.

"Let us take, for example," continues the scientist, "the last experiment we saw: the capability of a liquid to change viscosity. Any technologist or machine-tool operator will appreciate such a property. Extremely clever attachments are used in the machining of large, geometrically complex and thin-walled articles. And what could be simpler than to install an ordinary container holding a ferroliquid on a machine tool instead of an expensive piece of equipment? In it, under the influence of a magnetic field, the part is held firmly. When it is necessary to remove the finished article or change its position, just turn off the field."

A group of workers in the department have been occupied in working out the compositions of ferromagnetic liquids, studying their properties and selecting areas for their use for about 15 years. These unusual materials do have one characteristic feature: the solution is attracted and held by the field of a magnet or flows in the direction of a magnetic field. Such constancy of behavior, in combination with the great variety of special features that are characteristic of each type of liquid, makes them quite versatile.

A copper coin floats on kerosene that has iron particles suspended in it. An amusing anomaly, but is it only that? The fact of the matter is that from this "miracle" in the beaker of kerosene there runs a straight and short road to many millions of rubles' worth of savings of assets in the national economy. It has been calculated that a liter of this liquid does not cost more than 1 ruble. It can be produced in unlimited quantities. This is a straightforward reason for using it in processes for enriching useful minerals, so as to extract even from low-grade soil or wastes not one or several basic components, but all of the valuable substances in sequence. The accuracy of the separation of substances by specific weight has actually reached a level where "magnetic" kerosene can errorlessly "tell," for example, one grade of aluminum from another and expel to its surface pieces of metal in sequence.

When planning complicated machines, the designers frequently shake their heads: what is the best way to insure a sealed outlet of a running shaft from the housing of a unit? Although countless variants have been devised, they can all be reduced to a single, commonly known method: the gap is covered with rubber (or some other elastic material) gaskets. They wear out quite rapidly. Under extreme conditions, they prove to be entirely unsuitable. Other ways of sealing must be found and the equipment's design will probably be made more complicated.

"Here, also, a magnetic liquid can be of assistance," says Professor Ye.Ye. Bibik, a work supervisor, as he demonstrates a complex unit on a laboratory bench. "This sealing element for a vacuum pump is capable of serving reliably and for an unlimited length of time. The problem has been solved quite simply: the gap is covered with several drops of a ferroliquid and a magnet, which also serves to hold the solution in place. The successive installation of similar elements insures the sealing of equipment designed for operation under a pressure of hundreds of atmospheres. The movable

couplings of any machine -- from chemical equipment to marine propeller shafts -- are sealed reliably. For an axle, it is as if it is swimming in an extremely thin layer of liquid without touching the walls of its supporting structure. A unique bearing that operates with practically no friction is obtained."

Thousands of experiments have been performed in the Department of Colloid Chemistry. Step by step, the horizons for the use of ferromagnetic liquids are being broadened. In the opinion of the scientists, solutions with controllable viscosity can be used as the artificial, smoothly controlled "muscles" of robots instead of the lever and hydraulic designs now in use. They will also serve as an ideal cushion and can replace platforms that carry heavy loads. The possibility of developing systems for noncontact recording of information on ordinary paper has been proven. If recording tape is covered with a thin layer of a ferroliquid, the coded entry becomes visible. Their capability of changing from a state of transparency to complete opaqueness in thousandths of a second makes magnetic liquids suitable for use in optics. Doctors use them to stop the hemorrhaging from extremely small blood vessels during operations and, together with chemists, are searching for the formulas of compounds that in the near future will deliver doses of medicine directly to an ailing organ.

Dispersed ferromagnetic systems have advocates who are specialists and are studying them in Perm' and Stavropol', Riga and Minsk, Khar'kov and Nikolayev. A number of enterprises have laboratories and groups of enthusiasts are actively working in this field. However, their work is uncoordinated. The use of the liquids is also limited: there is simply nowhere to take them.

"The branch institutes and enterprises have written us a whole mountain of letters," says I.S. Lavrov, displaying a thick packet. "Of course, we try to satisfy the requests -- we send someone a liter, someone else 10 liters. But can you do a lot without a production base? The scientific inventory of applied research in our laboratory alone is large enough so that it would take an entire specialized institute to handle it. There is no subordinate unit that could solve the engineering problems entailed in the development of magnetic devices with optimum parameters. Chemists just are not able to do that."

The scientists' concern is completely understandable. Industry's requirements for universal reagents for the enrichment of minerals, and magnetic seals and lubricants in machine building, are growing, although the production technology for manufacturing ferroliquids in sufficient amounts is by no stretch of the imagination opening the way. Organizations in many departments, as is apparent from their correspondence with the Institute, are interested in using magnetic liquids. However, each of them thinks only of its own requirements. There is still no single patron capable of financing and organizing large-scale research and concerning itself with the introduction of the obtained results. Therefore, the marvelous properties of ferromagnetic liquids will not be at the complete disposal of the national economy.

[76-11746]

11746
CSO: 1862

USSR UDC 621.385

INFLUENCE OF ELECTRON BOMBARDMENT ON THE GROWTH OF FILMS OF CERTAIN METALS (Al, Cu, Sb) ON DIELECTRIC SUBSTRATES

Moscow VESTNIK MOSCOVSKOGO UNIVERSITETA SERIYA 3 FIZIKA - ASTRONOMIYA in Russian Vol 20 No 5, Sep/Oct 79 pp 54-62 manuscript received 9 Mar 78

DUBININA, YE. M., YELOVIKOV, S. S., OVSYANITSKIY, A. S., NETISHENSKAYA, G. P., and KIRILENKO, YE. P., Department of Electronics, Moscow State University

[Abstract] A study is made of the problem of the influence of electron bombardment on the growth of films of Al, Cu and Sb on single crystal NaCl (air cleavage) substrates and nonoriented substrates of glass-ceramic and silicon monoxide. The metals selected were used because of their broad application in electronics. The influence of electron bombardment on epitaxial growth of films is studied, as well as the influence of electron bombardment on the properties of Sb and Al films on nonoriented dielectric substrates. The experiments show that electron bombardment before and during formation of films decreases the epitaxial temperature of copper films by about 100°C, aluminum by about 150°C and antimony by about 180°C. Preliminary bombardment of the substrate and bombardment during the early stages of the process of condensation are particularly effective. The Auger spectra of films grown with and without bombardment at a condensation rate of 20 Å/s indicate that there is a smaller quantity of oxygen in the bombarded films. This may be explained by an increase in the supersaturation of Al over the bombarded surface of the film. Figures 5; references 14: 2 Russian, 12 Western.
[70-6508]

USSR

SUPERLUMINAL SOURCE IN A WAVEGUIDE

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR - FIZIKA in Russian Vol 14 No 4, 1979 pp 240-246 manuscript received 27 Apr 79

BEGLOYAN, E. A. and BEKOVA, S. KH., Yerevan Physics Institute, Dagestan Pedagogical Institute

[Abstract] An earlier work suggested a model of a superluminal source in a plane waveguide. However, the earlier work analyzed an idealized waveguide consisting of two parallel ideally conducting plates. The present work suggests a theory of radiation from a superluminal radiator for a regular waveguide of arbitrary cross section. Expressions are derived that can be used to compute the energy flux of transient radiation in a waveguide. The intensity of the Cherenkov radiation lines is proportional to the length of the trajectory of particles in transverse and effective longitudinal movement. Figure 1; references 4 Russian.
[72-6508]

USSR

SUPERSONIC PULSE DISCHARGE OF ARGON FROM A CONICAL NOZZLE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 11, Nov 79 pp 2516-2519 manuscript received 18 Jun 79

DOBRYNIN, B. M., KISLYAKOV, V. B. and MASLENNIKOV, V. G., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Pulse discharge of an underexpanded argon jet from a conical nozzle was studied in an experiment, with the 22° divergence angle designed for a flow velocity of N_{Ma} = 4.0 and with instruments based on an IAB-451 interferometer for measurements in a large shock tunnel. The stagnation parameters were determined from the velocity of an incident shock wave, the initial gas pressure and the pressure behind the reflected shock wave. Interferograms of the supersonic flow transient were interpreted by both the zone method and the method of least squares, the latter with some modifications. Radial density profiles indicate that the gas density increases downstream near the throat section of the nozzle and more uniform over the stream core farther from the throat, the core of the stream almost not changing while the width of the jet increases rapidly with a smooth decrease of density from the core toward the jet boundary. With the velocity of an incident shock wave equal to N_{Ma} = 2.9, the velocity at the nozzle throat varied from 3.75 to 3.9 within the core of the stream. Figures 2; references 5: 4 Russian, 1 Western.
[90-2415]

USSR UDC 534.12

THE AMPLITUDE STRUCTURE OF THE NEAR SONIC FIELD WITH INCLINED INCIDENCE OF A PLANE SONIC WAVE ON A CIRCULAR CYLINDER

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA - SERIYA 3 FIZIKA, ASTRONOMIYA in Russian Vol 20 No 4, Jul/Aug 79 pp 100-103 manuscript received 3 Mar 78

ARZHANOV, M. I., ROZHIN, F. V. and TONAKANOV, O. S., Department of Acoustics, Moscow State University

[Abstract] A study is made of inclined incidence of a plane sonic wave against an infinitely long cylinder with an acoustically soft boundary. Figures illustrate the distribution of amplitudes of pressure, radial and axial components of vibrational velocity as a function of distance r along

a straight line in the direction of the azimuth angle and perpendicular to the surface of the cylinder. Where $r = r_0 + 8\lambda$ for $kr_0 \leq 1$ the pressure of the scattered wave is 10% of the amplitude of the incident wave; where $kr_0 > 1$, this ratio is correct with greater values of $r > r_0 + 8\lambda$. Beyond the cylinder, at a distance of between r_0 and $r_0 + \lambda/4$, the amplitudes of pressure and velocity components of the scattered wave are small in comparison to the corresponding values of the incident wave, while at distances of around $r_0 + 8\lambda$, the distribution of pressure amplitude and velocity correspond to those of the incident wave even where $kr_0 = 8$. Figures 3; references 2 Russian.
[71-6508]

USSR UDC 532.517.4+534.526

TURBULENCE IN A "GRADIENT SUBLAYER" OF TWO-DIMENSIONAL DELAYED BOUNDARY LAYERS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249 No 2, 1979 pp 298-302
manuscript received 16 May 79

KADER, B. A., Moscow Institute of Chemical Machine Building

[Abstract] A two-dimensional steady turbulent boundary layer of an incompressible fluid over a smooth wall is studied, which is at equilibrium in the sense that the turbulence in the cross section with x = const (x is read out in the direction of the flow) depends only on the density, kinematic viscosity, flow velocity, thickness of the boundary layer and kinematic gradient of longitudinal pressure. A study is made of the regularities of pulsation movement in the gradient sublayer. Although the experimental data are rather widely dispersed, they generally agree with the theoretical conclusion that the standardized values of moments are described by universal functions of the variable $Y = y\alpha/u_*^2$, approaching a constant value where $Y \ll 1$ and proportional to $Y^{1/2}$ where $Y \gg 1$. Figures 2; references 15: 4 Russian, 11 Western.
[63-6508]

USSR UDC 539.3:534.1

VIBRATIONS OF A VISCOELASTIC PLATE IN A SUPERSONIC FLOW OF GAS

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian No 1, Jan/Feb 79 pp 184-188 manuscript received 25 Feb 77

ANVAROV, R. and GEGEL', E. I., Tashkent

[Abstract] Using the method of equivalent correspondence suggested in an earlier study (1975), a study is made here of the stability of induced vibrations of a viscoelastic plate in a plane supersonic gas stream. An analytical expression is arrived at for the critical velocity of the gas stream, taking into account the viscoelastic properties of the plate's material. The authors discuss small vibrations of a flat viscoelastic plate of infinite width, a thickness of 2h and a length of ℓ, moving in a straight line at a high supersonic velocity of U in a certain gas medium. Attack is not taken into account in motion of this plate in relation to the gas. An equation is derived for describing slight buckling of the plate on the assumption that the relationship between the stress and strain of the plate's material is in agreement with the linear theory of viscoelasticity and the forces of the aerodynamic effect are taken into account according to the piston theory. The case is discussed when the edges of the plate are hinged. A system of integrodifferential equations is obtained for vibration frequencies by employing the Bubnov-Galerkin method. A system of differential equations is derived from the system of integrodifferential equations in vector matrix form by the method of equivalent correspondence in a first approximation. A solution to this final system is studied for stability. The magnitude of a parameter dependent on the viscoelastic properties of the plate's material determines the critical value of the velocity of a viscoelastic plate. Taking viscous drag into account results in lowering of the critical velocity of the plate as compared with the similar problem in an elastic formulation. References 10: 9 Russian, 1 Western.
[69-8831]

USSR UDC 621.378.325

FREE-ELECTRON LASERS

Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 129 No 3, Nov 79 pp 541-547

KUZNETSOV, V. L.

[Abstract] A free-electron laser, or e-laser operates on the basis of the radiation of a relativistic electron flux moving in an external electromagnetic field. If the electron radiates while moving in a coherent field of an external signal, a new photon will very probably be emitted at the same frequency and in phase with the external stimulating field. This mechanism of amplification and generation of electromagnetic radiation has been experimentally demonstrated quite recently. Experiments at Stanford University have confirmed the theoretical ideas and served as a stimulus for further development in this area. Some of the advantages of e-lasers are noted: simple creation of an inverted population of energy states, easy frequency control by changing the energy of the electron flux and unlimited theoretical possible power of signal generated. A quantum interpretation of the problem of e-lasers is presented, along with means for optimization of e-laser systems using spherical mirrors. It is noted that all but one of the works in the literature on the subject assumed the presence of an external resonator. References 49: 12 Russian, 37 Western.
[73-6508]

USSR

EXTENSION OF THE OPERATING TIME OF A GAS-DYNAMIC PULSE LASER WITH A SHOCK TUBE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 11, Nov 79 pp 2331-2337 manuscript received 19 Feb 79

TESTOV, V. G., GRIN', YU. I., MISHIN, G. I., PETROV, R. L., GRIGOR'YEV, V. V. and MENENKOV, V. D., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] A gas-dynamic laser with a shock tube is considered, and extension of the operating time during which the parameters of the working gas at the end of the low-pressure channel remain uniformly distributed so that the pattern of a collocated contact surface can develop. The optimum conditions under which this operating time will be maximum are established on

the basis of the fundamental relation for the operating time as a function of gas and channel parameters as well as the thermodynamic relations for a shock wave. This theoretical analysis is followed by an analysis of experimental data pertaining to two laser mixtures: 0.1 CO_2+ 0.1 N_2+ 0.8 He and 0.1 N_2O+ 0.2 N_2+ 0.7 He. Measured were the laser emission and amplification as well as the optimum tube length and the optimum operating time as functions of the partial nitrogen pressure in the propelling gas at the nozzle entrance, also the life of an active laser medium there. Measurements were made with the Mach number at the channel end remaining below its value corresponding to a collocated contact surface. The results indicate that it is feasible to extend the operating time in the collocated-contact-surface mode. Figures 5; references 18: 9 Russian, 9 Western.
[90-2415]

USSR UDC 621.378.33

DOUBLE SELF-MODE LOCKING IN A RUBY LASER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 11, Nov 79 pp 2436-2438 manuscript received 19 Mar 79

VARNAVSKIY, O. P., KOLDAŞHOV, G. A., LEONTOVICH, A. M. and MOZHAROVSKIY, A. M., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Double self-mode locking in a ruby laser was studied experimentally, with an 80 cm long resonator cavity formed by two plane mirrors with reflection coefficients of 1.0 and 0.8 respectively. A lens with a focal length of 1500 cm was placed inside this cavity for compensating the thermal lens in the ruby and for producing an unstable resonator. A glycerin solution of cryptocyanide with a relaxation time of 75-100 ns served as a nonlinear saturating absorption filter with a 0.4 initial transmission coefficient. The resonator cavity of this filter, made half as long as the main resonator cavity, was formed by a plane mirror with a reflection coefficient of 0.75 and an opaque mirror with a radius of 150 cm. The axes of the two resonators were at a 30° angle to each other. A signal from the dye was found to have a period equal to half the period of a main emission signal and to lag 50 ns behind. A pulse train of radiation from the dye peaked 19 ns later than a pulse train of radiation from the ruby. With both resonator cavities equally long, emission from the dye was unstable. The feasibility of shortening the pulse duration under conditions of double self-locking was examined by a numerical solution of the balance equations of coupled emission from a ruby and a dye, a calculated 30% decrease agreeing

closely with experimental data, but no attempt was made to optimize the emission from the dye. The authors thank M. D. GALANIN for his interest and attention. Figures 2; references 9: 3 Russian, 6 Western.
[90-2415]

USSR UDC 621.378.325

LASER BREAKDOWN OF TRANSLUCENT POLYMERS WITH VARIOUS ATOMIC COMPOSITIONS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 11, Nov 79 pp 2496-2497 manuscript received 12 Apr 79

ALDOSHIN, M. I., GERASIMOV, B. G., MANENKOV, A. A., MASLYUKOV, A. P., NECHITAYLO, V. S. and PONOMARENKO, YE. P., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A broad class of polymers with various atomic compositions and various viscoelastic characteristics (polymethyl methacrylate, polymethacryl ether of ethylene glycol, polystyrene, polybutyl methcrylate, and several copolymers of these or methyl methacrylate) was subjected to breakdown by laser irradiation. A multimodal ruby laser emitting giant 20 ns pulses with a smooth waveform and a uniform spatial distribution was used as the source. Bulk breakdown thresholds under single irradiation and laser resistance under repetitive irradiation were measured in terms of the number of pulses at a fixed prethreshold laser intensity that a specimen could absorb prior to visible microcracks. The results confirm the prediction that viscoelastic characteristics influence the laser resistance of not only aliphatic polymers but also of polymers containing aromatic fragments, a lower limit of stimulated elasticity corresponding to a higher laser resistance, while variations in the atomic composition do not significantly affect the laser resistance. Tables 1; references 1 Russian.
[90-2415]

USSR UDC 539.12

DISTRIBUTION OF THE FASTEST PARTONS AND HADRONS IN A HADRON STREAM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249 No 2, 1979 pp 341-345
manuscript received 3 Jul 79

BAYER, V. N. and GROZIN, A. G., Institute of Nuclear Physics, Siberian Division of USSR Academy of Sciences, Novosibirsk

[Abstract] The formation of a stream of hadrons upon interaction of high energy particles is one important prediction of the parton model. According to quantum chromodynamics, the distribution of hadrons carries an imprint of the initial parton distribution arising upon development of a parton shower in the case of large momentum transfers. In this work, a study is made of the distribution of the most rapid partons and hadrons in a jet within the framework of the principal logarithmic approximation of quantum chromodynamics. Results of modeling at 20 GeV are shown, based on 2,226 events. The quark jet arising upon e^-e^+ annihilation was studied. The current results are compared with the predictions of Field and Feynman. Figures 2; references 4: 1 Russian, 3 Western.
[63-6508]

USSR UDC 533.951

EFFECT OF THE INTRINSIC ELECTROMAGNETIC FIELDS OF HIGH-CURRENT ELECTRON BEAMS ON THEIR TRAJECTORIES

Tomsk IZV. VUZ: FIZIKA in Russian No 10, Oct 79 pp 27-46

DIDENKO, A. N. and RYABCHIKOV, A. I., Scientific Research Institute of Nuclear Physics, Tomsk Polytechnic Institute imeni S. M. Kirov

[Abstract] Methods of controlling the trajectories of relativistic high-current electron beams propagating through a neutral gas have been studied at the Scientific Research Institute of Nuclear Physics as well as in other laboratories. Reflection at surfaces of adjacent ferrodielectric media under conditions of charge and current neutralization provides an efficient mechanism, especially at low residual gas pressures, due to the role played by the intrinsic electromagnetic fields of such beams and the attendant self-focusing effect. Cherenkov radiation also plays a role, but a significant one only initially after beam injection into the gas and polarization of the dielectric wall. The intrinsic fields of such a beam also facilitate its propagation through transverse magnetic fields along plasma channels.

Methods of thus controlling the trajectories of relativistic high-current electron beams can be effectively used for formation of dense electron rings and for heating plasmas or targets to thermonuclear temperatures. They can also be used for more precise and undistorted measurements in experimental studies. Figures 5; references 36: 26 Russian, 10 Western.
[88-2415]

USSR UDC 533.951

RELATIVISTIC HIGH-CURRENT MICROWAVE PLASMA ELECTRONICS

Tomsk IZV. VUZ: FIZIKA in Russian No 10, Oct 79 pp 47-58

BOGDANKEVICH, L. S., RABINOVICH, M. S. and RUKHADZE, A. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] A survey is presented of achievements in relativistic microwave plasma electronics, particularly in devices operating with high-current electron beams. Included are Cherenkov oscillators (traveling-wave tubes, backward-wave tubes, magnetrons) and cyclotron generators (gyrotrons), based respectively on Cherenkov radiation and on magnetic bremsstrahlung of a free fast electron. Their performance characteristics are analyzed here from the standpoint of attainable beam currents, these characteristics being determined essentially by the dependence of power and efficiency on the gas pressure and the plasma density. Design and performance improvements are traced from the first Cherenkov oscillators (USSR 1973, USA 1974) and the first gyrotrons (USSR 1974, USA 1975). Figures 7; tables 2; references 21: 17 Russian, 4 Western.
[88-2415]

USSR UDC 533.951.2.3

ACCELERATION OF IONS IN RECTLINEAR HIGH-CURRENT ELECTRON BEAMS

Tomsk IZV. VUZ: FIZIKA in Russian No 10, Oct 79 pp 59-82

GAPANOVICH, V. G. and KOLOMENSKIY, A. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Results of research in the USSR and in the USA on acceleration of ions by high-current electron beams are reviewed, particularly those mechanisms and techniques which have recently reached a very high level of theoretical and experimental development. As an alternative to acceleration of ions by electron rings, much attention has been paid to their acceleration by injection of a high-current electron beam into a neutral gas under minimum pressure, and to consideration of the effects of pressure gradients and longitudinal magnetic fields as means of increasing that acceleration. Ions have also been accelerated in Luce vacuum diodes with a dielectric anode and, more recently, by high-current electron beams propagating through dielectric tubes. Other methods include the use of gaseous lenses displacing the beam crossover along its axis, acceleration of ions by scanning with the beam of an electron microscope or by uniform rotation of the electron beam, in each case the crossover being displaced transversely, also acceleration of ions by the quasi-static field of high-current electron beams and, finally, self-resonant acceleration of ions. Figures 6; references 85: 39 Russian, 46 Western.
[88-2415]

USSR UDC 533.951.2.3

HIGH-CURRENT-PULSE ION BEAMS

Tomsk IZV. VUZ: FIZIKA in Russian No 10, Oct 79 pp 83-105

BYSTRITSKIY, V. M., Scientific Research Institute of Nuclear Physics, Tomsk Polytechnic Institute imeni S. M. Kirov

[Abstract] High-current ion beams offer two advantages over high-current electron beams in controlled inertial thermonuclear fusion, namely high ionization losses with the released energy peaking toward the end of the beam path at the target and a nearly complete absence of bremsstrahlung with its adverse effect of preheating the fuel. High-current-pulse ion beams are now generated either by classical ring accelerator-accumulators

or by collective acceleration in a plasma (electron beams, clusters). Another method is their generation with modified diode guns of nanosecond high-current accelerators. In order to produce an efficient ion gun, it is necessary to suppress the electron component, and various methods of achieving this are based essentially on implications of the Childs-Langmuir law. Here several devices for this purpose are described, namely a triode and a twin diode where multiple reflections of electrons occur, a magnetic-isolation diode where electrons are cut off, and a pinch-effect diode where a radially focused electron beam forms with an axial ion beam in the interelectrode gap of a smoothly adjustable width. Design and performance data on the VERA and the TONUS ion beam generators at the Tomsk Polytechnic Institute are compared with those characterizing several in the United States (Cornell University, National Research Laboratories, SANDIA). Figures 8; tables 1; references 91: 13 Russian, 78 Western.
[88-2415]

USSR UDC 535.231.12

CHERENKOV RADIATION OF MONOCHROMATIC BEAMS OF PARTICLES CONSIDERING THEIR INTERACTION

Moscow VESTNIK MOSCOVSKOGO UNIVERSITETA SERIYA 3 FIZIKA - ASTRONOMIYA in Russian Vol 20 No 5, Sep/Oct 79 pp 71-74 manuscript received 16 Jun 78

LUPANDIN, I. V., Department of Quantum Theory, Moscow State University

[Abstract] The purpose of this work is to derive and qualitatively analyze equations for the intensity of Cherenkov radiation of a beam of particles moving in a fixed direction (with negligible divergence), low dispersion of speeds and initial coordinates. This statement of the problem is of interest due to the possibility of constructing a model of an experiment for detection of interference effects and studying parameters of beams of charged particles. References 4: 2 Russian, 2 Western.
[70-6508]

USSR UDC 537.56

NUCLEAR RELAXATION OF He^3 ATOMS IN A GAS DISCHARGE AT LIQUID-NITROGEN TEMPERATURE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 11, Nov 79 pp 2462-2465 manuscript received 12 Jan 79

KARTOSHKIN, V. A., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Relaxation of He^3 nuclei in a mixture of He^3 + He^4 isotopes at a temperature of 77 K was studied experimentally in an absorption chamber under a pressure below 1 torr. The relaxation time for nuclear spins was determined from measurements of the transient process following application of an r-f magnetic field at resonance with the 2^3S_1 state. A new equilibrium orientation of half-levels of the metastable helium state will occur after one of three characteristic time periods, the reciprocal of each equal to the reciprocal of the nuclear relaxation time minus a correction term. The results yield a dependence of the He^3 nuclear relaxation time t on the concentration of metastable helium atoms n which can be approximated by the relation $t \sim n^{-1.5}$. This trend is attributable to resonant He^+ ion charge exchange on helium atoms in the ground state, the main relaxation process at low pressures. The contribution of He_2^+ atoms becomes significant at high pressures. The author thanks R. A. ZHITINKOV for his attention. Figures 2; references 5: 1 Russian, 4 Western.
[90-2415]

USSR UDC 535.51

RECONSTRUCTION OF THE DEGREE OF POLARIZATION OF A WAVE FIELD BY POLARIZATION HOLOGRAPHY

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 96 No 1, 1979 pp 73-76 manuscript received 27 Jul 79

KAKICHASHVILI, SH. D., Institute of Cybernetics, Academy of Sciences Georgian SSR

[Abstract] Electromagnetic waves are almost always partly polarized due to scattering and reflection of radiation, fluctuation effects in radiating systems and so forth. Partly polarized radiation can be resolved in the form of two components with mutual orthogonal polarization and mutual complete incoherence, and with maximum difference in intensities. The measure of partial polarization is defined as $V = (I_{max}-I_{min})/(I_{max}+I_{min})$, where I_{max} and I_{min} are the intensities of the maximum and minimum components. The authors solve the problem of reconstruction of this parameter by polarization holography. It is found that a necessary condition for solving the problem is the use of photoanisotropic media as the holographic material, and a reference wave that is completely unpolarized. Experiments in polarization recording were done in both transmitted and reflected light. The results show that reconstruction of the degree of polarization is possible in both the Gabor and Denisyuk methods. References 8: 7 Russian, 1 Western. [84-6610]

USSR UDC 538.566:621.372.413

EXPERIMENTAL STUDY OF THE CHARACTERISTICS OF THE DIFFRACTION YIELD OF AN UNSTABLE QUASIOPTICAL RESONATOR

Moscow VESTNIK MOSCOVSKOGO UNIVERSITETA SERIYA 3 FIZIKA - ASTRONIMIYA in Russian Vol 20 No 5, Sep/Oct 79 pp 91-93 manuscript received 4 May 78

KOROLEV, F. A., deceased, and BOGOMOLOV, V. C., Department of Optics and Spectroscopy, Moscow State University

[Abstract] Measurements of the output characteristics of an unstable resonator were performed at a wavelength of 7.2 mm. The diffraction picture beyond the output mirror of the resonator was visualized by movement of the receiver in the horizontal plane perpendicular to the axis of the resonator. An equation is presented for the distribution of the field near the output

mirror, which describes Fraunhofer diffraction on a circular aperture and agrees well with the experimental data. The equation can be used to estimate the degree of concentration of energy in the central portion of the output beam. Figures 3; references 7: 6 Russian, 1 Western.
[70-6508]

USSR UDC 533.951.7

SOME PROBLEMS OF THE QUASILINEAR PLASMA THEORY

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA - SERIYA 3 FIZIKA, ASTRONIMIYA in Russian Vol 20 No 4, Jul/Aug 79 pp 22-28 manuscript received 14 Mar 78

KUZ'MENKOV, L. S. and POLYAKOV, P. A., Department of Theoretical Physics, Moscow State University

[Abstract] A study is made of the quasilinear plasma theory considering radiation effects. Consideration of the resulting nonlinear terms in the equations describing the plasma causes the mean equilibrium distribution to be time dependent and results in the appearance of interaction between waves, greatly complicating the theoretical analysis of plasma phenomenon. However, in a collisionless plasma, radiation attenuation in many practically important cases is more important than Landau attenuation. The relativistic kinetic equation of Vlasov is analyzed considering radiation deceleration of particles. Consideration of radiation effects results in changes in the distribution function of particles of the plasma both when Langmuir waves propagate through the plasma and when electromagnetic waves propagate through it. The full energy of the particles of the plasma for propagation of Langmuir waves is not retained due to radiation deceleration. When electromagnetic waves propagate through the plasma, the increase in mean momentum and energy of particles results from a decrease in the momentum and energy of waves. Figures 2; references 8: 7 Russian, 1 Western. [71-6508]

USSR UDC 621.791.052.539.43

STUDY OF THE INFLUENCE OF THE SHAPE OF THE WELD AND OF THE STRAIN INHOMOGENEITY OF WELDED BUTT JOINTS ON MECHANICAL ENDURANCE

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR, MEKHANIKA in Russian Vol 32 No 4, 1979 pp 56-62 manuscript received 17 Jan 79

MKRTCHYAN, L. S., Yerevan State University

[Abstract] A determination is made of the theoretical value of the critical angle and of the influence of the shape of the groove of a welded butt joint on mechanical endurance as a function of the strain inhomogeneity of the weld zone. The starting point for analysis is an equation for determining the critical combination, in terms of a low degree of stress on the edge of the contact surface, of values of angles between flat elements of the contact surface in the vicinity of its edge and the outer surface of the joint, for the general case of stressing a jointed body. This equation is simplified for the case of a machined smooth edge on the contact surface. It is shown that for a smooth edge by means of elementary computations it is possible to determine the critical (upper-limit) angle for the material with the lower elastic modulus. The material of the weld in a welded joint is as a rule highly inhomogeneous in terms of both chemical composition and mechanical properties, including strain properties, and thermal effects during welding can substantially alter the strength properties and almost have no influence on the strain properties of the material of the heat-affected zone. By knowing the strain properties of the weld material and of the base material it is possible to calculate the groove angles of a welded joint so that the conditions for a low stressed state can be fulfilled along the entire edge of the fused surface. The results are given of experiments in which grade 20 steel samples from the same melt were welded with a general-purpose ANO-6 electrode of the E42-t type with an ilmenite covering. A determination was made of the elastic constants of the weld metal on welded butt joint specimens measuring 3 X 5 X 40 mm. The mean value of the elastic modulus of the fused metal was 1.8 X 10^6 kg/cm^2 with a Poisson's ratio of 0.29. The mean value of the elastic modulus of the base metal was 2.12 X 10^6 kg/cm^2 with a Poisson's ratio of 0.32, and elastic constants were determined by tensile testing specimens cut from rolled sheets. Shear moduli are calculated for the weld metal and the base metal and it is found that the shear modulus of the weld metal, in terms of which the critical angle is calculated, is lower than that of the base metal. The critical angle is found to equal in this case $\leq$ 59°30', i.e., in this case the edge of the surface of contact will be in a low state of stress. Results are given of experiments conducted for the sake of comparing the endurance of a V-type weld with a backup weld and without one. Fatigue tests were conducted on grade 20 steel with a maximum stress of 12.5 kg/m^2 and a minimum stress of 2.5 kg/m^2, and it was found that under these conditions the endurance of

a V-type weld without a backup weld is 1.5-fold lower than that of a V-type weld with backup. The employment of a V-type weld with a backup weld equalizes the angles in the upper and lower halves of the joined materials and thus removes the concentration of stresses in these areas. Fatigue tests were conducted with a TsDM PU-10 push-pull fatigue testing machine at a rate of 100 cycles/min. Figures 3; references 5: 4 Russian, 1 Western. [68-8831]

USSR UDC 539.385

SHELL OF REVOLUTION OF MAXIMUM TORSIONAL RIGIDITY

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian No 1, Jan/Feb 79 pp 138-144 manuscript received 16 Jun 77

GURA, N. M., Moscow

[Abstract] The problem is studied of finding the optimal design of a shell of revolution having maximum torsional rigidity with a predetermined volume of the shell. Several variants of this problem are discussed, employing as control functions, in conjunction or separately, the form of the meridian of the middle of the surface and the distribution of thickness along the meridian. The influence of torque on the thickness of the shell is discussed in particular. The equation of equilibrium is written and boundary conditions are set for two variants: when the shell of revolution is fastened at both edges and when one edge is free and the other is fastened. The optimization problem consists in finding functions h(z) or R(z) or h(z) and R(z) together which will satisfy the isoperimetric condition, based on the assumption of a predetermined volume and known radii of the shell's edges, such that a minimum is realized for a functional describing the displacement. Here h is the thickness of the shell, R is the radial torque, and z is the z-axis of the shell. For the case of a shell of revolution with a free edge a determination is made of the optimal distribution of thickness, h(z), and of the form of the meridian of the middle of the surface, R(z). A determination is made of the optimal design of a shell of revolution for the case when function h(z) serves as the control function and function R(z) is assigned. The optimal distribution of thickness is found for a conical shell. In order to take into account the influence of torque on the optimal distribution of thickness, numerical methods of solving the optimality condition are used. Also discussed is the problem when the form of the meridian of the center of the shell's surface serves as the control function and the thickness of the shell is an assigned function. It is demonstrated analytically that if there is sufficient material, then the form of the meridian tends to depart as much as possible from the axis of

revolution. If there is too little material, then the form of the meridian tends toward a catenary, i.e., to a shell of minimal surface. The case is also considered when both the thickness of the shell and the form of the meridian of the center of the surface are control functions. Here, too, the form of the meridian of the surface's center depends on the area of the surface: For an optimal torque-free shell it is better to use more material to reduce the torsional force than to economize on material and reduce the surface of the shell, thereby increasing the torsional force. The necessary condition of optimality is derived which the thickness of the shell must satisfy for the case when both edges of the shell are closed and function R(z) is known. Figures 5; references 5: 3 Russian, 2 Western.
[69-8831]

USSR UDC 539.3:534.1

INITIAL POSTCRITICAL BEHAVIOR OF CYLINDRICAL SHELLS UNDER EXTERNAL PRESSURE

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian
No 1, Jan/Feb 79 pp 155-162 manuscript received 24 Nov 77

BADENKO, V. I., Khar'kov

[Abstract] Based on the results of high-speed motion picture photography of the process of the loss of stability, i.e., buckling, of a cylindrical shell, a method is suggested for deriving asymptotic equations for the critical load and forms of equilibrium at the initial postcritical stage of developable shells under external pressure. A study is made of the loss of stability in a closed cylindrical shell with a strictly convex cross section, assuming that the shell is fairly thin, of moderate length, linearly elastic and hinged along the edge. The method used here considers the problem of determining the critical load and of describing the periodic structure of postcritical strains in cylindrical shells independent of one another and unrelated. It is suggested that the form of equilibrium at the initial postcritical stage of a developable shell under external pressure differs considerably from the subcritical, or close to zero-moment stage, only in the narrow vicinity of a certain generating line, γ, of the center of the surface, F, of the shell. Buckling begins with the formation of a single dent stretching along γ. The theoretical discussion begins with nonlinear equations of the theory of the "average buckling" of flat shells in dimensionless form. An asymptotic solution is found to this system of equations, in terms of the minor parameter of a relatively thin-walled state. A vector function, U, is introduced, and in each of the regions of $F_{i\beta}$, representing two subregions of two regions into which F is divided,

an asymptotic form is constructed for U in the form of a series in terms of the square root of the relative wall thickness parameter. One term of this series, U_{11}^{0}, is determined from solution of the boundary value problem, and a trivial solution to this problem describes subcritical strains. Postcritical strains are in accord with nontrivial solutions to the boundary value problem. An asymptotic form is found for a nontrivial solution to the system of equations describing the boundary problem. The resultant pressure dependence of maximum buckling agrees qualitatively with the conclusions of an earlier theory (1968). References 4: 3 Russian, 1 Western.
[69-8831]

USSR UDC 539.3

THE STRESSED STATE OF UNEVENLY HEATED PLATES LOADED ON THE BOUNDING SURFACES

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 43 No 6, Nov/Dec 79 pp 1065-1072 manuscript received 26 Jun 78

MAKSIMOVICH, V. N., L'vov

[Abstract] The stresses $\tau_{zx} = \tau_{zy} = 0$, $\sigma_{zz} = \sigma_{\pm}$, $z = \pm h$ are assigned on the boundary planes of a uniformly heated layer of thickness 2h. The symmetric and antisymmetric problems are solved separately: 1) at constant temperature under given conditions on the bounding planes; 2) with given nonuniform heating and zero stresses. Simple formulas are given for determining the stressed state in the case of slowly varying external loading and temperature of an infinite plate. References 10 Russian.
[80-6610]

USSR UDC 531.383

CERTAIN CASES OF INSTABILITY OF A DIRECTIONAL GYROSCOPE

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian
No 1, Jan/Feb 79 pp 5-10 manuscript received 4 Jan 78

AGAFONOV, S. A., Moscow

[Abstract] A theoretical study is made of the stability of the precessional motion of a directional gyro for the case when the point of suspension of the gyrosphere moves along a parallel at a steady speed. Equations for the precessional motion of the system are given for these conditions and the case is considered when $0 < \mu \leq 1$, where $\mu = v^2/gR$, where v is the absolute velocity of the point of the suspension, g is the acceleration of the force of gravity and R is the radius of the earth. The motion equations also take into account the mass of the entire system, the distance from the center of mass of the system to the point of the suspension, the angular momentum of the gyroscopes, the angular velocity of diurnal rotation of the globe, the latitude of the object's position, the easterly component of the velocity of the point of the suspension, and angles defining the position of the gyrosphere in relation to the geographical system of coordinates. An investigation is made of the cases when internal resonance of the third order exists between frequencies of the linear system and when one of the frequencies equals zero. A particular solution is given for the system of equations of precessional motion, and the sufficient condition for the stability of this solution, derived from the condition for positive definiteness of the integral of the equations for perturbed motion, is $\omega^2 < \nu^2 (1 - \nu)$, where $\nu^2 = g/R$. The case of internal resonance of the third order is that in which $\omega_1 = 2\omega_2$. It is demonstrated that internal resonance of the third order results in instability. Cases of $\omega = \nu(1 - \mu)^{1/2}$ and $\omega = \nu$ are discussed. It is demonstrated for the case when one of the frequencies equals zero that instability is proven by means of plotting a Chetayev function (Chetayev, N. G., "Ustoychivost' dvizheniya" [Stability of Motion], Moscow, Nauka, 1965), in the form of $V = \kappa y_1 y_2 - y_1$, where $\kappa > 0$ is a certain constant and the region of $V > 0$ is defined by the inequalities $y_1 < 0$ and $y_2 < 0$. Instability is demonstrated by means of the functions $V = \kappa y_1 y_2 + y_1$ and $V = y_1 y_2 - y_2$, respectively, for the cases of $\omega = -\nu\sqrt{1 - \omega}$ and $\omega = -\nu$. The frequencies referred to, ω and ν, are found in the characteristic equation for the linear half of the system of equations for perturbed motion, which in turn are derived from equations for the precessional motion of a directional gyro when the point of the suspension of the gyrosphere moves along a parallel at a constant velocity. References 8 Russian.
[69-8831]

USSR UDC 531.55:521.1

ORIENTATION OF A SATELLITE IN A PREDETERMINED DIRECTION

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian No 1, Jan/Feb 79 pp 11-18 manuscript received 19 Apr 76

SAAKYAN, L. S., Yerevan

[Abstract] A method is given for plotting control moments applied to a satellite whose center of mass describes a circular orbit in a Newtonian field of forces for the restricted case when the influence that motion around the center of mass has on the motion of the center of mass is disregarded. The solution of the problem of orienting the satellite in a predetermined direction, α, is found by finding a control moment, M, which when applied to the satellite combines vector n, which is a basis vector whose position remains unchanged in the moving system of coordinates $Ox_1x_2x_3$, with vector α and stabilizes this direction. The inertial system of coordinates, $O_1\xi\eta\zeta$, has as its origin the center of gravity, O_1, and the origin of the moving system of coordinates, $Ox_1x_2x_3$, is the satellite's center of mass, O, with axes pointing along the main central axis of inertia. An orbital system of coordinates, Oxyz, is introduced, with the z axis pointed along straight line OO_1, axis x in the direction of movement of the center of mass along the straight line orthogonal to axis z and located in the plane of orbit, and axis y complementing axes x and z to form a right trihedron. Representing the basis vectors of axes z and y are α and β, respectively. The case is considered of two orthogonal basis vectors, n and m, rigidly linked to the satellite. It is assumed that in moving system of coordinates $Ox_1x_2x_3$ are measured only the projections of vectors α, β and β^*. The problem is solved of, employing the projections of vectors α, β and β^*, plotting a control moment, M, which will stabilize predetermined senses of n and m in relation to the senses of the radius vector to the normal of the circular orbit. Also considered is the case of a gyrostat-type satellite in which along the main axes of inertia of the satellite are placed the axes of three similar symmetric flywheels which are rotated by special motors. Given are two orthogonal basis vectors, n and m, rigidly linked to the gyrostat-type satellite. The problem is solved of applying to the flywheel a control moment, M, making it possible to stabilize basis vector n in the direction of the radius vector of the circular orbit, and basis vector m in the direction of the normal to the plane of the stationary orbit. The need for employing special instruments to measure various of the magnitudes discussed theoretically is stressed. Conditions are found whereby with the application of control moment M applied to the flywheels so that the satellite is oriented in assigned directions α and β, any movement of the gyrostat-type satellite is either a position of relative equilibrium or asymptotically approaches this position. Figure 1; references 7 Russion.
[69-8831]

USSR UDC 531.383

EMPLOYMENT OF METHODS OF IDENTIFICATION FOR ESTIMATING ERRORS OF DOUBLE-ROTOR GYROCOMPASSES ON A ROCKING BASE

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian
No 1, Jan/Feb 79 pp 27-31 manuscript received 10 Jan 78

POTEMKIN, A. E., Odessa

[Abstract] Errors differing by two to three orders of magnitude from the actual values are obtained when calculating errors of double-rotor gyrocompasses with rocking, by employing the precession theory without taking into account the elastic compliance of structural elements and their inertia, the flow of fluids and possible free play in the pivots of the gyroscope's suspension. It is possible to take into account these factors by employing a mathematical model of a gyroscope system based on experimental data with consideration of the joint effect of both known and unknown factors causing an error in the gyroscope system. Examples are given of the application of the method of identification for constructing a mathematical model from the input and output variables of a system when it is functioning. The employment of methods of identification makes it possible to arrive at a more adequate model of a system which takes into account both the theoretical and certain structural features of the gyroscope system. It also makes it possible more accurately to predict its output coordinate under the effect of disturbances. Experimental methods of constructing models are based on the assumption that the parameters of the object are lumped, that the dynamic properties are stable over time and that they are linear with slight variations in input coordinates. A model is constructed by selecting a structure for the model from physical considerations, determining the criteria for comparing modeled and experimental characteristics, which criteria depend on the requirements for the precision of modeling and on the amount and completeness of experimental data, by matching the parameters of the model with the available experimental data (estimating), by testing and confirming the adequacy of the model over all ranges of possible external disturbances, and by using the model for its purpose. Equations are obtained for computing the intercardinal errors of a gyrocompass in regular and irregular rocking. One system of equations based on the laws of mechanics and another system based on methods of identification by employing experimental data on the errors of a gyrocompass is employed to compute the errors resulting from rocking. There is good agreement between the calculated and experimental results. The mathematical model arrived at for a gyrocompass can be used for investigating the influence of rocking and maneuvering of a ship for the entire range of instruments employing a device of this sort. References 12 Russian.
[69-8831]

USSR UDC 531.383

THEORY OF A GYROSCOPE ON A ROTATING CARDAN SUSPENSION

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian
No 1, Jan/Feb 79 pp 31-33 manuscript received 30 Jul 77

TERESHIN, V. G., Ufa

[Abstract] An analysis is made of the capabilities of a gyroscope on a rotating Cardan suspension for determining the parameters of angular motion of a base. It is demonstrated that a gyroscope of this sort can be used as a vibration-sensing device for slowly varying angular velocities. A discussion is given of the dynamics of a gyroscope with forced uniform rotation of the Cardan suspension. The assumption is made that the suspension's structure employs elastic elements having infinitely high flexural rigidity and finite torsional rigidity. Linked to the base is a system of axes $O\xi_1\eta_1\zeta_1$ whose position relative to inertial system of coordinates $O\xi\eta\zeta$ is defined by angles Θ and Ψ. The position of the gyroscope's main axis, Oz, is determined by the angles α and β read from axes $O\xi_2\eta_2\zeta_2$ linked to an auxiliary ring which rotates at a constant angular velocity of ω around axis $O\zeta_1$. The angular rotational velocity of the ring, Ω, is an order of magnitude higher than velocities Θ^* and Ψ^*. Linearized differential equations are given, describing the motion of a gyroscope on a rotating Cardan suspension on a fixed base. The useful signal bearing information on Θ^* and Ψ^* consists of the amplitude and phase of the envelope of angular vibrations of the gyroscope's rings taking place at the frequency of forced rotation of the auxiliary ring. These angular vibrations depend on both measured velocities Θ^* and Ψ^* simultaneously. Consideration of the law of motion of a gyroscope for the case of separating a signal in a non-rotating system of coordinates shows that the useful signals are the amplitude and phase of the envelope of angular vibrations taking place at double the frequency of the forced rotation, and also the steady deflections of the gyroscope's main axis. These steady deflections depend on angular velocity Θ^* for one angle and on angular velocity Ψ^* for another angle. A gyroscope on a rotating Cardan suspension represents a generalized dynamic model of vibration-sensing detectors of the parameters of angular movement of the base. Slowly varying angular velocities Θ^* and Ψ^* can be measured simultaneously regardless of which gimbal's angle of turn the signal is derived from and in which system of coordinates. Figures 1; references 5: 4 Russian, 1 Western.
[69-8831]

USSR UDC 539.3:534.1

CALCULATION OF NONLINEAR PARAMETRIC VIBRATIONS OF CYLINDRICAL SHELLS

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian
No 1, Jan/Feb 79 pp 171-177 manuscript received 24 Nov 77

BOGDANOVICH, A. YE. and FELDMANE, E. G., Riga

[Abstract] A procedure is established for selecting the required number and kind of basis functions approximating the buckling of a shell with nonlinear parametric vibrations. In expanding buckling in terms of forms of natural vibrations, it is necessary to take into account only the harmonics in the region of dynamic instability that contains specific values of the amplitude and frequency of the external load. It was found in earlier studies that when the amplitude and frequency of the influencing load fall within the region of instability in the parameter plane the amplitude of the buckling increases exponentially with time, and if the parameters fall within the region of stability, buckling of the construction is on the order of magnitude of original imperfections. The position and form of regions of dynamic instability are determined totally from solving the linear problem of parametric vibrations and the various nonlinear factors at work under real conditions of use of a construction result in limitation of buckling over time even within regions of dynamic instability. A closed, round, mildly sloping isotropic cylindrical shell loaded with an axial force of the $P = (P_0 + P_t \cos\theta_t)/(2\pi R)$ type, where R is the radius of the center of the shell's surface, is discussed for the purpose of illustrating the method of selecting functions approximating buckling with nonlinear parametric vibrations. Two known equations for average buckling describe the reaction of the shell with mild strains but finite displacements, disregarding tangential components of the reduced load and inertial terms. An expression is derived for the stress function from the first of these equations. By substituting this expression and a certain approximation for buckling in the equilibrium equation and applying the Bubnov-Galerkin procedure, a system of ordinary differential equations is arrived at. It is demonstrated that in solving the problem of nonlinear parametric vibrations the choice of the buckling approximation must be determined on the basis of the nature of the position of regions of dynamic instability of the design under consideration. It is demonstrated that it is necessary to calculate the entire range of regions of dynamic instability for all possible forms which can be realized in the frequency range of interest. The case is discussed when a point on the plane of parameters corresponding to a specific load amplitude and frequency lies in the intersection of two regions for certain forms. In the particular case discussed, vibrations for both forms are of a beat frequency nature. Buckling at a certain point on the shell represents the superposition of two beat frequencies. These two beat frequencies occur for different circular forms of wave formation and their superposition creates a complex pattern

of vibrations in the diametric cross section of the shell. By solving the nonlinear system of two equations for average buckling by employing the Bubnov-Galerkin method, it is possible to expand the buckling in a double Fourier series in terms of the longitudinal and circumferential coordinates of the shell. By solving the corresponding linear problem and knowing from this the diagrams of regions of dynamic instability, it is possible to establish what terms in these expansions must be taken into account with a specific combination of the amplitude and frequency of the external load. Figures 3; references 13: 9 Russian, 4 Western.
[69-8831]

USSR UDC 519.3

CONCERNING A GENERALIZATION OF A THEOREM FROM THE THEORY OF OPTIMUM STABILIZATION

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, 1979 pp 3-8 manuscript received 14 Dec 77

RAKHIMOV, M., Turkmen State University imeni A. M. Gor'kiy

[Abstract] The author considers the problem of optimum stabilization of distributed systems where the process is described by hyperbolic and parabolic equations. The method of finding the optimum control proposed by A. I. Yegorov ("Optimum Stabilization of Systems with Distributed Parameters. Abstracts of Papers of the International Technical Conference. IFIP optimizatsii," Novosibirsk, 1974) gives specific recommendations for studying a number of questions of optimization of systems with distributed parameters. An examination is made of one of the generalizations of a theorem proposed by Yegorov for a parabolic system. References 6 Russian.
[74-6610]

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USSR UDC 534.231:535.211

ACOUSTIC PERTURBATIONS IN A MEDIUM DUE TO LIMITED MOTION OF A HEAT SOURCE AT THE SPEED OF SOUND

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26 No 1, Jan/Feb 80 pp 35-40
manuscript received 22 Jun 79

BOZHKOV, A. I., BUNKIN, F. V. and KOLOMENSKIY, AL. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Motion of three-dimensional heat sources at a velocity approaching that of sound is considered and the resulting acoustic perturbations in the medium are analyzed, this motion being limited by finiteness of the source action. With a sufficiently low source power and a sufficiently short trajectory, the problem can be treated as a transient one without dissipation and nonlinear effects taken into account. Assuming the heat source to be turning on and off instantaneously, and the wave front to be plane, the second-order differential equation for the pressure as a function of the thermal power density is here solved with the aid of a Green's space-time function for zero initial values. The solution reveals that the pressure along the trajectory rises linearly when the path is short within the range where the effect of diffractive divergence remains weak and rises logarithmically when the path is longer with the effect of diffractive divergence becoming strong. The results of this analysis are applicable to a heat source produced by a scanning laser beam in an absorbing fluid. Typical calculations are shown for a Gaussian laser beam scanning a water surface. References 10: 9 Russian, 1 Western.
[106-2415]

USSR UDC 534.26

PROPAGATION OF ACOUSTIC WAVES THROUGH A PLANE WAVEGUIDE WITH THIN ELASTIC WALLS IN A FLUID MEDIUM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26 No 1, Jan/Feb 80 pp 112-121
manuscript received 13 Jun 78; after revision 6 Jul 79

LEVITSKIY, L. A.

[Abstract] The author considers a waveguide formed by two parallel thin elastic plates in an ideal compressible fluid and propagation through it of acoustic waves excited by a harmonic point source inside. The sound pressure is calculated from the Helmholtz equation and the principle of limiting absorption. The equation of dynamics for a plate in a fluid is solved with the continuity of vertical displacements at the plate-fluid interfaces as

the boundary condition. The energy which a surface wave in such a system transmits along a plate, on the inside and on the outside of the waveguide is also calculated. The method of steepest descents is used for the far-field zone. In the case of semitransparent plates some energy is always lost to radiation. Nevertheless every normal mode is found to become strongly underdamped at a certain critical frequency. There is also energy dissipated by the fluid. The ratio of energy transmitted by a wave to energy transmitted along the waveguide increases with a larger wave number, and faster so as the distance between the plates increases. The author thanks D. P. KOUZOV for formulating the problem and for the helpful discussion.
Figures 6; references 5 Russian.
[106-2415]

USSR UDC 533.6.011.72+534.2:532

SPECTRUM OF AN INTENSIVE HYDROACOUSTIC PULSE REFLECTED FROM A WATER SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26 No 1, Jan/Feb 80 pp 137-139
manuscript received 11 Mar 79

GORSKIY, S. M., PETUKHOV, YU. V. and FRIDMAN, V. YE., Scientific Research Institute of Radiophysics, Gor'kiy

[Abstract] Reflection at the free water-air boundary of a pressure pulse coming from an acoustic point source at some depth below the ocean surface is considered, cavitation being negligible here as long as the pulse has a not very large amplitude. The spectrum of the reflected pulse reveals a redistribution of energy at the surface, low-frequency components becoming more intensive and high-frequency components becoming less intensive after reflection. Calculations are made for the two extreme cases of detonation occurring near the surface or very deep below it. In the first case one can disregard nonlinear distortion of the incident shock wave and assume that the reflected wave has an exponential profile. In the second case one can assume that the incident shock wave is triangular at the surface and the reflected wave has a profile $p = -(t/x)$ $(0 \leq t \leq x)$, $p = (t - 1)/(1 - x)$ $(x \leq t \leq 1)$ when $0 \leq x \leq 1$ and $p = -(t/x)$ $(0 \leq t \leq \sqrt{x})$ when $x \geq 1$. Here x denotes the depth coordinate referred to a characteristic radius and t denotes time referred to a characteristic period. Figures 1; references 4: 3 Russian, 1 Western.
[106-2415]

USSR UDC 621.375.8

A STUDY OF HYPERSOUND GENERATION BY A COHERENT FOCUSED LIGHT PULSE

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 2, Aug 79 pp 250-256 manuscript received 19 Mar 79

LITVINENKO, G. I., LOKHOV, YU. N. and FIVEYSKIY, YU. D.

[Abstract] Hypersound generation in the case of Mandelshtam-Brillouin stimulated scattering in a solid optically transparent dielectric by a focused laser pulse is theoretically analyzed for the case of large Stokes component gains. The dielectric is assumed to be isotropic and homogeneous, and lattice inclusions and defects are absent in the focal volume. The focal distance is assumed to be sufficiently small to avoid self-focusing of the laser radiation. The temperature of the focal volume of the dielectric is assumed constant during the scattering process and nonlinear pressure effects are neglected. The limits to the latter assumption are indicated. Since the greatest pumpback of the laser energy to the Stokes components occurs for the case of scattering at an angle of 180° to the direction of laser radiation propagation, this is the case studied here. The three-dimensional problem is solved in a parabolic approximation of the slowly changing amplitudes of the electromagnetic field and hypersound pressure. Expressions are derived for the scattering threshold and they are analyzed as a function of the focal distance of the focusing lens. It is shown that the hypersound generation dynamics account for the experimentally observed widening and shift of the frequency of the Stokes component. A sample calculation for the case of fused quartz and a ruby laser where the focal distance is 6 cm, the pulse width is $2 \cdot 10^{-8}$ and the temperature 300 K, shows that the radiation power density at the focus must be much less than 10^{12} watts/cm^2. The range of applicability of the expressions derived in the laser field approximation is determined by the hypersound pressure at which the nonlinear pressure processes can be disregarded. References 16: 9 Russian, 7 Western.
[186-8225]

USSR

THE PHASON IN THE SUBMILLIMETER SPECTRUM OF $CsCuCl_3$ SINGLE CRYSTALS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 2, Jan 80 pp 107-110 manuscript received 23 Nov 79

VOLKOV, A. A., KOZLOV, G. V., LEBEDEV, S. P., PETTSEL'T, YA. and BRZHEZINA, B., Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences

[Abstract] The dielectric spectra of $CsCuCl_3$ crystals in the submillimeter band were investigated to find excitations of the crystal lattice related to phase transitions leading to a helicoid modulated structure in the low-temperature phase. The $CsCuCl_3$ crystals were grown from an aqueous solution of cesium and copper chloride in the molecular ratio of 1:2 by temperature reduction in the range of 313-308 K and at pH of 3.5. The observed low-frequency mode is directly related to phase fluctuations of a helicoid modulated structure. Phase transition in $CsCuCl_3$ crystals is the first recorded case of nonferroelectric phase transition in nonpolar point groups in which one of the soft mode components becomes active in the infrared spectrum. Figures 3; references 9: 3 Russian, 6 Western.

USSR

RESONANCE EXCITATION OF Nd^{3+} IN A SINGLE CRYSTAL OF A Gd_2S_3 SEMICONDUCTOR

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 2, Jan 80 pp 114-117 manuscript received 24 Nov 79

GLUSHKOV, M. V., MAMEDOV, A. A., PROKHOROV, A. M., PUKHLIY, ZH. A. and SHCHERBAKOV, I. A., Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences

[Abstract] The absorption spectra of Gd_2S_3 semiconductor and the emission spectra of a Nd^{3+} ion were investigated by the resonance laser excitation method at different temperatures. The neodymium concentration in the Gd_2S_3 comprised 1 percent by weight. Effective impact collision of impure centers by carriers in the electric field is possible in semiconductors of type $A_2^{III}B_3^{VI}$ activated by trivalent ions of rare earth elements and these materials can be used as the active medium of a new type of laser. Figures 3; references 6: 5 Russian, 1 Western.

USSR

HEAT-CAPACITY ANOMALIES IN GAMMA-IRRADIATED CRYSTALS OF TRIGLYCIN SULFATE

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 31 No 3, 5 Feb 80 pp 184-187 manuscript received 27 Dec 79

STRUKOV, V. A., SIGOV, A. S., FEDORIKHIN, V. A. and TARASKIN, S. A., Moscow State University imeni M. V. Lomonosov

[Abstract] The evolution of heat-capacity anomalies in crystals of triglycine sulfate under the influence of small gamma radiation doses is studied for the first time. Comparison of the data produced with a phenomenological theory considering the influence of noninteracting defects on the nature of anomalies in the region of phase transitions is used to estimate the concentration of defects arising in a crystal upon irradiation. Results are presented from studies of the heat capacity of a crystal of TGS grown at a temperature higher than the second order phase transition temperature T_c as a function of gamma radiation dose. The temperature dependence of heat capacity is graphed for several radiation doses. Figures 2; references 3 Russian.
[99-6508]

USSR UDC 534.2:532

PARAMETERS OF A DETONATION WAVE REFLECTED FROM A WATER SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26 No 1, Jan/Feb 80 pp 150-151 manuscript received 11 Mar 79

PETUKHOV, YU. V. and FRIDMAN, V. YE., Scientific Research Institute of Radiophysics, Gor'kiy

[Abstract] A wave is generated by detonation of a charge deep under the water surface and then reflected at the surface. The parameters of the reflected wave are calculated here and compared with the corresponding parameters of the wave arriving directly from the source. The profile of the original wave remains exponential near the source, within a characteristic radius, and becomes triangular beyond that radius. When detonation occurs deep below the surface, therefore, then the reflected wave will have a Riemann profile. A directly arriving signal and a reflected signal will be of equal durations at some depths and of equal amplitudes at other depths. In addition to the locus of equal-duration depths and the locus of equal-amplitude depths, there is a third locus of points at which discontinuity in the profile of the reflected wave occurs. Figures 1; references 3 Russian.
[106-2415]

USSR UDC 532.517

STABILITY OF A BOUNDARY LAYER ABOVE THE SURFACE OF A WAVE TRAVELING THROUGH A PLATE

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5, Sep/Oct 79 pp 49-52 manuscript received 17 Oct 78

AYZIN, L. B. and VOLODIN, A. G., Novosibirsk

[Abstract] The stability of the boundary layer of an incompressible fluid above a rigid plate surface with a wave traveling parallel to the stream is analyzed, this problem being treated as a two-dimensional one in the linear approximation. The potential in the inviscid region and the flow function for the laminar region are referred to a system of coordinates traveling with the wave. Assuming a Blasius velocity profile and using the Orr-Sommerfeld operator, the solution to the linearized equation for the perturbation flow function is sought in the form of a power series with respect to

the wave amplitude. Numerical integration of this Sommerfeld-Orr equation for a flow with the Reynolds number ranging from 520 to 3500 yields, with appropriate corrections, the limit of neutral stability for a Tolmin-Schlichting wave as a function of the Reynolds number and of the phase velocity. The results indicate that waviness of the surface distorts the steady-state velocity profile within a narrow range, contributing to stability below and causing instability above. The authors thanks S. A. GAPONOV for pointing out the analogy between these results and those based on a nonlinear theory. Figures 2; references 6: 5 Russian, 1 Western.
[105-2415]

USSR UDC 533.6.011.55

SUPERSONIC NONEQUILIBRIUM FLOW ALONG THE LATERAL SURFACE OF BLUNT BODIES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5, Sep/Oct 79 pp 68-72 manuscript received 24 Jul 78

LABNOVA, L. A., POLYANSKIY, A. F. and SKURIN, L. I., Leningrad

[Abstract] A laminar stream of air not at chemical equilibrium along the lateral surface of a blunt cone moving at supersonic velocity is analyzed, assuming the presence of an external electric field and an electric current due to ionization within the flow region but disregarding any effects of radiation. The boundary conditions are given in terms of a zero normal velocity component, a constant temperature and an equilibrium concentration of all gases (O_2, N_2, O, N, NO NO^+, e) at the body surface. Only mass interdiffusion is assumed to occur, with constant values of the Schmidt number, within the boundary layer. Examined are the normal profiles of temperature and electron concentration, also the dependence of the total hydrodynamic drag coefficient and of the Stanton number on the flight altitude and on the cone geometry, i.e., bluntness radius and divergence angle. Experimental data are shown pertaining to a cone flying at a velocity of 7.4 km/s and compared with those for a cone without blunting of the vertex. Blunting to a radius of 1 cm, with a divergence angle of 9-10°, is found to raise the ionization level by almost three orders of magnitude but to have little effect on the thermal and the hydrodynamic characteristics. Figures 4; references 15: 6 Russian, 9 Western.
[105-2415]

USSR UDC 532.526+533.6.011.55-3

FLOW WITHIN A SUPERSONIC BOUNDARY LAYER AT BODIES WITH A POWER-LAW PROFILE AND WITH MASS TRANSFER ACROSS THE SURFACE

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 73-80 manuscript received 25 Oct 78

DUDIN, G. N., Moscow

[Abstract] The author considers supersonic flow around a slender body with a power-law profile in a viscous gas with attendant mass transfer across the surface. Insertion of variables referred to the body surface and letting the Reynolds number become infinite reduces the Navier-Stokes equations to equations of a three-dimensional boundary layer, which written in Dorodnitsyn variables are solved here for boundary conditions corresponding to a wing with a profile $z_e = x^m$ and a boundary layer $\delta_b = x^1 \Delta_b(z/z_e)$ (z_e being the coordinate of the front edge). In the case of forced air injection or suction across the surface, further constraints are imposed and another change of variables is made to bring the problem to a self-adjoint form. Results of calculations are shown which pertain to symmetric flow around a wing, with the viscosity assumed to be linearly dependent on the temperature. The profiles of displacement thickness and thermal flux as well as the profiles of longitudinal and transverse friction stresses are found to change with the rate of injection (positive) or suction (negative). Figures 6; references 7: 5 Russian, 2 Western.
[105-2415]

USSR UDC 532.529.5

FRICTIONAL STRESS AT A WALL IN AN ASCENDING LIQUID-GAS STREAM

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 80-87 manuscript received 15 May 78

BURDUKOV, A. P., KASHINSKIY, O. N. and ODNORAL, V. P., Novosibirsk

[Abstract] An experimental study was made of frictional stress, at the wall, due to slow ascending flow of a liquid-gas stream through a 6.5 m high vertical pipe with an inside diameter of 86.4 mm. The liquid phase was an aqueous solution of 0.5 N NaOH and 0.01 N $Fe(CN)_2$+ $Fe(CN)_3$, as the gas phase was nitrogen. The mixture was driven through this pipe and another vertical return-flow pipe by a centrifugal pump having a capacity of 50 m^3/h at a

pressure head of 6 atm. After each flow cycle the mixture was passed through a separator, from where the nitrogen was exhausted into the atmosphere and the liquid was returned to the pump for further use. Nitrogen was fed into the stream through the lateral surface of a porous pipe and its temperature at the inlet to the main pipe was held at 24±0.5°C. The velocity of the ascending stream was varied from 0.44 to 2.05 m/s and the nitrogen content in the nixture was varied from 0 to 80 vol.%. The frictional stress was measured by the electrochemical method and the gas concentration profiles were measured by the electrical conductivity method, under conditions of bubble flow and shot flow. The gas concentration profiles indicate that the sharp rise of frictional stress during bubble flow with a low gas content is due to sharp peaks of gas concentration near the pipe wall. The velocity of ascending gas bubbles is comparable with the local velocity of the liquid, which distorts the velocity profile and results in a larger velocity gradient at the wall. Figures 6; references 16: 7 Russian, 9 Western.
[105-2415]

USSR UDC 534.833.53

EXPERIMENTAL EVALUATION OF THE RATE OF GROWTH OF MICROBUBBLES IN A TURBULENT STREAM

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5, Sep/Oct 80 pp 87-91 manuscript received 11 Jul 78

GAVRILENKO, V. G. and MART'YANOV, A. I., Gor'kiy

[Abstract] The authors consider the feasibility of evaluating the rate of growth of free bubbles in a turbulent submerged water jet from measurements of the gas nucleation profile and its evolution along the jet axis. Such an experimental evaluation is based on the equation of continuity with respect to concentration of gaseous nuclei, assuming no instantaneous but only gradual buildup and collapse of bubbles dissolved within the jet region. This equation is solved for the rate of growth when $\frac{\partial}{\partial R}(\frac{\partial R}{\partial t}) \to 0$ (R denoting the bubble radius and t denoting time). Experiments for such an evaluation were performed in a hydroacoustic tank with bubbles inside a circular tube and within a jet flowing into the tank, the distribution of bubbles within the $(2.25\text{-}13)\cdot 10^{-4}$ cm range of radii being measured and the bubble growth rate then being determined as functions of the distance from the nozzle throat. An analysis of experimental data reveals the dynamics of bubble growth in a turbulent stream and indicates that the number of bubbles of any size group is maximum at a distance from the nozzle throat approximately equal

to twice the nominal radius corresponding to this group. The authors thank A. N. BARKHATOV and L. A. OSTROVSKIY for the interest and helpful suggestions. Figures 1; tables 1; references 5 Russian.
[105-2415]

USSR UDC 532.72

CONVECTIVE HEAT AND MASS TRANSFER IN A MOVING REGULAR ARRAY OF DROPS OR BUBBLES WITH HIGH VALUES OF THE PECLET NUMBER

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 99-103 manuscript received 14 Aug 78

POLYANIN, A. D. and SERGEYEV, YU. A., Moscow

[Abstract] Convective diffusion is considered in a dense array of precipitating spherical drops or levitating bubbles, all moving at the same velocity in an infinitely large volume of a liquid at rest and forming straight vertical strings separated by a distance of the same order of magnitude as the distance between drops or bubbles in one such string. The boundary layer around each drop or bubble is assumed to be linear. The problem of mass transfer in such an array is solved with the flow function near a surface, according to this model of a Stokes flow, expressed in spherical coordinates. Convective diffusion is here regarded as a quasi-steady process and, on this basis, the equation of steady convective diffusion is solved for drops or bubbles with the Peclet number $Np_e \gg 1$, as in an extraction column, and their concentration distribution calculated accordingly. The mean concentration is found to decrease exponentially with time and with distance from the inlet, and to increase exponentially with velocity. This relation, appropriately modified, is useful for calculating the mean concentration of a discrete reactant phase in a continuous dispersing phase at any time at any height in a reactor vessel with a finite volume. Figures 1; references 5: 2 Russian, 3 Western.
[105-2415]

USSR UDC 620.193.6

LASER-INDUCED CAVITATION IN LIQUID NITROGEN

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 103-106 manuscript received 10 Oct 78

COLUBNICHNIY, P. I., DYADUSHKIN, P. I., KALYUZHNYY, G. S., KORCHIKOV, S. D. and KUDLENKO, V. G., Voroshilovgrad

[Abstract] An experimental study was made of laser-induced cavitation in a liquid nitrogen. The apparatus consisted of a neodymium laser, a focusing lens and a cryostat made of an optical material containing the liquid nitrogen. The laser pulses were of 10 ns duration with a maximum energy of $3 \cdot 10^{-2}$ J per pulse. Auxiliary equipment included an intensifying helium-neon laser, a photomultiplier and a red filter. The principal cavitation parameter, namely the ratio of maximum to minimum bubble radii, was measured by the shadow method with recording of optical pulse signals. As a result the pressure dependence and the temperature dependence of this ratio were determined as well as the pressure dependence of the period of the first bubble pulsation. The compression ratio was found not to exceed 6, at an excess pressure of 2 atm and a temperature of 65 K. Increasing this ratio requires raising the external pressure and thus lowering the gas content in the nitrogen sample. Figures 5; references 5 Russian.
[105-2415]

USSR UDC 669.15

AMORPHIZATION OF METALLIC ALLOYS UNDER LASER ACTION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249 No 5, 1979 pp 1118-1120 manuscript received 27 Jun 79

KYASHKIN, V. M., ZHDANOV, G. S. and MIRKIN, L. I., Moscow State University imeni M. V. Lomonosov

[Abstract] The authors investigate the action of laser radiation on equiatomic powder mixtures in the binary systems Cu-Zr and Ni-Nb on massive copper and nickel backings. The powder layers were 0.3 mm thick on backings 6 mm thick. A glass plate was used to press the powder against the backing. Laser emission was produced by a neodymium glass laser in the millisecond pulse mode. Analysis of the resultant alloy structures shows that amorphization occurs in a narrow range of exposure conditions: deviation from the optimum pulse energy by 10-15% produces purely crystal phases. In fact, it was discovered that no completely amorphous alloy could be produced, which may be attributed to nonuniformity of cooling conditions, incomplete mixing of the powders, and the considerable thickness of the alloy layer. Another factor could be vaporization of the components leading to a change in concentration. Figure 1; references 9: 5 Russian, 4 Western.
[86-6610]

USSR

STIMULATED MANDEL'SHTAM-BRILLOUIN SCATTERING IN AN EXTERNAL TRANSVERSE CAVITY

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 2, Jan 80 pp 103-106 manuscript received 22 Nov 79

ZASKAL'KO, O. P., SERDYUCHENKO, YU. N., STARUNOV, V. S. and FABELINSKIY, I. L., Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences

[Abstract] The results of experimental investigation of the spectral and time characteristics of stimulated Mandel'shtam-Brillouin scattering in an external transverse cavity, which is a laser that emits picosecond light pulses, are reported. The time and spectral characteristics of stimulated Mandel'shtam-Brillouin scattering did not vary with variation of distance between cavity mirrors from 6 to 9.5 cm, indicating self-locking of the stimulated Mandel'shtam-Brillouin scattering components. Locking of the

cavity modes was found experimentally in the case of stimulated light scattering of the limb of the Rayleigh line and during stimulated Mandel'shtam-Brillouin scattering in long waveguides, and mode locking in both cases occurred within the amplification band of each of the types of light scattering. The experiments indicate that there is a mechanism which creates a hypersonic wave common to all stimulated Mandel'shtam-Brillouin scattering components. Figures 2; references 6: 5 Russian, 1 Western.

USSR

SYNCHRONIZATION OF THE STIMULATED MANDEL'SHTAM-BRILLOUIN SCATTERING COMPONENTS IN A LASER CAVITY

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 2, Jan 80 pp 136-138 manuscript received 18 Dec 79

VOROB'YEV, N. S., SHIPILOV, K. F. and SHMAONOV, T. A., Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences

[Abstract] The effect of synchronization of stimulated Mandel'shtam-Brillouin scattering components was investigated as the basis for a new method of short laser pulse generation. The time parameters of the output pulse were measured by means of a coaxial photocell electrooptical chamber and a time interval meter. The mechanism of ultrashort pulse generation during synchronization of stimulated Mandel'shtam-Brillouin scattering components is confirmed. Figures 1; references 3 Russian.

USSR UDC 621.373.535

AN OPTICAL RING RESONATOR WITH A DIAPHRAGMED SPHERICAL MIRROR AND A SPATIALLY HETEROGENEOUS AMPLIFYING MEDIUM. PART 1

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA - FIZIKA-KHIMIYA in Russian No 10, Issue 2, May 79 pp 35-41 manuscript received 5 Jul 77

BOYTSOV, V. F. and SLYUSAREV, S. G.

[Abstract] The fields and frequency spectrum are calculated for the oppositely directed waves in a diaphragmed resonator with a spatially heterogeneous amplifying medium. Since the precise solution of this problem requires cumbersome machine calculation, models are studied for which closed

analytic solutions are available. The model selected is a ring resonator with two flat mirrors and one spherical mirror, with a diaphragm with normal distribution of transmission. Within the resonator is a square-law medium, the axis of symmetry of which passes through the optical axis of the empty resonator. One advantage of this model is that it allows determination of the basic properties and peculiarities of the actual physical system. The model problem is formulated, the optical path length in the heterogeneous medium is calculated, an integral equation is derived for the field in the resonator with the diaphragm, and the equation is solved to determine the field of the oppositely directed waves, threshold conditions and resonator frequency. Figure 1; references 15: 13 Russian, 2 Western.
[98-6508]

USSR UDC 621.373.535

ANNULAR OPTICAL RESONATOR WITH IRISED SPHERICAL MIRROR AND SPATIALLY INHOMOGENEOUS AMPLIFYING MEDIUM. II

Moscow VESTNIK LENINGRADSKOGO UNIVERSITETA: FIZIKA, KHIMIYA in Russian No 16, Issue 3, Aug 79 pp 38-44 manuscript received 5 Jul 77

BOYTSOV, V. F. and SLYUSAREV, S. G.

[Abstract] The first part of the paper was published in "Vestnik Leningradskogo universiteta," No 10, 1979 pp 35-41. On the basis of integral equations for open resonators, formulas were derived for the spatial distribution of the fields of opposed waves, the frequencies and threshold conditions in an amplifying medium partly filling a ring cavity with two flat mirrors and one spherical mirror. In the second part, a physical analysis is made of the results, and the caustic surfaces of zero modes are calculated for opposed waves inside the medium. The change in relation to an empty cavity is determined for the volumes of the fields between caustics due to diffraction by a gaussian diaphragm on the spherical mirror, and by the inhomogeneities of the amplifying medium. The equiphase fronts of the opposed waves are also calculated. It is found that the presence of a gaussian diaphragm on the spherical mirror and an amplifying medium that is "quadratic" in the transverse direction results in distortion of the caustics of the opposed waves. The relative deformation of the caustics depends on the losses in the cavity, and is less for cavities that are close to flat or concentric. References 4 Russian.
[93-6610]

USSR UDC 548:535

THE STIMULATED EMISSION OF MIXED MOLECULAR CRYSTALS AT LOW TEMPERATURES (REVIEW)

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 2, Aug 79 pp 189-204 manuscript received 24 Jul 78

NABOYKIN, YU. V. and OGURTSOVA, L. A.

[Abstract] The specific features of the stimulated emission from mixed crystals excited in the impurity absorption band by a high power laser and cooled down to a temperature at which their electron spectra undergo substantial changes, become line spectra and exhibit easily resolvable vibrational structures are treated in this survey of recent literature. The following topics are covered: the influence of the relaxation of intramolecular vibrations on the stimulated emission spectrum; the influence of electron-phonon interaction on the stimulated emission spectrum of mixed crystals; lasers using mixed molecular crystals at low temperatures; the polarization of the radiation and its manifestation in stimulated emission. Relaxation times for the vibrational levels of such crystals as naphthalene, phenyl-beta-naphthyldivinylbenzene and numerous others are presented in tabular form along with data on the lasing of mixed molecular crystals at 4.2 K. The practical importance of research on these crystals is indicated: the narrow lasing lines, the large pumping energy conversion gain and the frequency stability make mixed crystals promising media for solid state and gas lasers. Figures 11; references 40: 29 Russian, 11 Western. [186-8225]

USSR UDC 621.378.525

A HELIUM-NEON LASER FOR CARBON DIOXIDE GAS ANALYSIS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 2, Aug 79 pp 236-241 manuscript received 28 Aug 78

MIRONOV, V. D., POPOV, A. I. and PROTSENKO, YE. D.

[Abstract] The output power of a 4.2 micrometer helium-neon laser is optimized theoretically and checked experimentally. He-Ne lasers using the $3s_2$-$3p_1$ 4.2 micrometer transition of neon, where this wavelength is effectively absorbed by CO_2, can be used to make highly sensitive, high speed meters of CO_2 concentration. However, previous output powers with this transition have been low and difficult to record. The reason for this is

the nonoptimal choice of the active medium parameters, the resonator and the manner of lasing suppression at competing neon transitions of $3s_2$-$3p_4$ at 3.3922 micrometers and $3s_2$-$3p_2$ at 3.3912 micrometers. Structural modifications of an LG-75 laser to circumvent these difficulties are described, and an output power of 2.8 mW is reported; this figure is close to the theoretical maximum for lasers of this configuration. Simple analytical expressions are given for the absorption and emission probabilities of the relevant transitions, as well as the related output power. Figures 2; references 15: 5 Russian, 10 Western.
[186-8225]

USSR UDC 621.378.325

A RHODAMINE 6G DYE LASER USING A REFERENCE STANDARD SOLUTION AND AN UNSTABLE RESONATOR

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 31 No 2, Aug 79 pp 242-245 manuscript received 11 Aug 78

BARIKHIN, B. A., BOROVKOV, V. V., FEDOSIMOV, A. I. and YAKOVLEV, V. I.

[Abstract] Dye lasers using rhodamine 6G in configurations with flat and telescoping resonators were used to experimentally determine the optimal parameters of an astable resonator and evaluate its efficiency. An LG-55 He-Ne laser was used for the initial adjustment of the resonator and the final adjustment was accomplished with an AK-400 telescope after the solution attained optimal homogeneity. The spacing between the reflectors was determined by the degree of optical homogeneity of the solution and varied in a range of 0.8-1.3 m. The linear magnification of the resonator M, varied from 3.2 to 6.0 due to the changing diameter of the output reflector. The optimal operating mode of an astable resonator laser is achieved at a value of M = 3.5 and the optimum rhodamine 6G concentration in the solution is always less in the case of the astable resonator ($2 \cdot 10^{-5}$ mole/liter) than for a flat resonator ($2.6 \cdot 10^{-5}$ mole/liter). Photographic and calorimetric measurements of the far field distribution show that in a laser with an astable resonator, 50% or more of the generated radiation energy is liberated in an angle of less than $8 \cdot 10^{-3}$ rad under optimum conditions, while less than 20% of the energy of a flat resonator laser is radiated at this angle. A distinctive feature of rhodamine 6G laser operation in a reference standard with an astable resonator is the appearance of two or more kinds of different intensity in the spectrum instead of a broad continuous band, which is characteristic of lasers with flat resonators. The maximum radiation energy achieved in the astable resonator case was 300 joules at

an energy efficiency of 0.75% relative to that stored in the capacitor bank. It is shown that flat resonator lasers are less efficient than an astable one and the use of astable resonators for organic dye lasers allows for a substantial improvement in the parameters of the generated radiation pulse. No quantitative accounting for the results is given. Figures 4; references 5 Russian.
[186-8225]

USSR UDC 621.378.34

THE SPECTRAL LUMINESCENCE AND LASING CHARACTERISTICS OF 2-(4-BIPHENYLYL)-5-PHENYLOXAZOLE

Minsk ZHURNAL PRIKLADNOY SPEKTRASKOPII in Russian Vol 31 No 2, Aug 79 pp 257-264 manuscript received 31 Aug 78

GRUZINSKIY, V. V. and SUCHKOV, V. I.

[Abstract] The lasing properties of a number of new active media based on aryl derivatives of oxazole and oxadiazole are studied. The absorption, fluorescence, phosphorescence, superluminescence and lasing spectra of two compounds are investigated: 2-(4-biphenylyl)-5-phenyloxazole (BPO) and (1,4-bis[2-(5-phenyloxazolyl)]benzene) (POPOP). The second harmonic of a ruby laser employing a telescopic system was used for pumping, where the maximum energy converted by a KDP single crystal was 0.12 J, and the base pulse width was 50 nanoseconds. Transverse pumping was used and a diffraction grating was used as one of the resonator reflectors for tuning the wavelength. In the fluorescence spectra of BPO and POPOP, linear bands at about 357, 380 and 420 nanometers are the strongest, where these are due to the emission of molecular nitrogen formed during the destruction of the oxazole ring of the molecules. BPO and POPOP molecules are less stable in a discharge than aromatic compounds such as anthracene or perylene. Lasing of these compounds was obtained in cyclohexane, pentane, dioxane, ethyl acetate, cyclohexanone, toluene, ditolylmethane and alpha-methylnaphthalene in concentrations ranging from 0.05--2 g/l. The experiments with a one meter long resonator show that these aryl derivatives are capable of strong lasing and fluorescence in the above mentioned vapors and solutions with optical excitation; they are promising as the active media in the search for lasing in an electric discharge. Figures 5; references 16: 14 Russian, 2 Western.
[186-8225]

USSR UDC 621.378.325

AN ELECTRON-BEAM-CONTROLLED LASER FACILITY WITH A COOLED ACTIVE REGION

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 12, Dec 79 pp 2629-2636 manuscript received 31 Mar 79

BASOV, N. G., DANILYCHEV, V. A., IONIN, A. A., KAZAKEVICH, V. S., KOVSH, I. B., PANTELEYEV, G. V., POLETAYEV, N. L., SOBOLEV, V. A. and TROITSKIY, V. F., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] For purposes of studying the temperature dependences of the energy, time and spectral characteristics of molecular lasers, an experimental facility was developed for electron-beam excitation of a lasing medium with a volume of about 5 liters at initial temperatures from 80 to 300 K. The installation operates at gas densities of up to 3 amagat units, and is suitable for typical working mixtures of electron-beam-controlled CO and CO_2 lasers, providing specific energy inputs of up to 300-500 J/liter × amagat unit. The duration of the pumping pulse can be varied over a range from about 1 to 500 μs. The facility is used to study the temperature dependence of laser threshold characteristics. Figures 5; references 12: 5 Russian, 7 Western.
[95-6610]

USSR UDC 621.378.325

METAL SEGMENTED PIPES FOR GAS-DISCHARGE PULSE LASERS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 12, Dec 79 pp 2643-2646 manuscript received 11 Feb 79

KRAVCHENKO, V. F., GUDKOV, A. A., KARABUT, E. K. and MIKHALEVSKIY, V. S., Scientific Research Institute of Physics at Rostov-na-Donu State University

[Abstract] Segmented metal tubes are widely used for cw lasing in argon and carbon dioxide. The authors investigate the feasibility of such tubes for pulse lasers. The analysis is based on an ultraviolet nitrogen gas-discharge laser. The discharge tubes were 20 cm long with diameter of the envelope of 3 cm. Aluminum segments were used with thicknesses ranging from 0.01 to 1.8 cm with spacing from 0.1 to 4 cm. The diameter of the discharge section was a constant 0.3 cm. It is shown that for the same source of excitation and the same volume, a segmented metal tube has greater lasing power than

conventional dielectric discharge tubes. The lasing efficiency in the segmented metal tube is 0.02-0.035%, which is close to the value for dielectric tubes. The experimental results are interpreted in terms of the hypothesis of a hollow-cathode effect in the segments. Figures 4; references 5: 3 Russian, 2 Western.
[95-6610]

USSR UDC 621.378.325

CHARACTERISTICS OF THIN-FILM METALLIZED MIRRORS FOR PULSED LASER SYSTEMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 49 No 12, Dec 79 pp 2662-2666 manuscript received 16 Apr 79

VOLYAK, T. B., GALKINA, N. S., KRASYUK, I. K., PASHININ, P. P., TROFIMOVA, A. A. and SHARAFUTDINOVA, D. I., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] An investigation is made of metallized mylar films used as laser mirrors. The mirror surface is formed by stretching the film on a special frame over a cavity where a pressure drop is set up to produce the required curvature. Wrinkles and warps are removed by annealing followed by slow cooling. A shadow technique was used for studying the mirrors with a helium-neon laser light source. An aluminized glass mirror was used as the standard. It was found that a gold mirror on mylar film is best able to withstand laser radiation. The threshold of destruction of such a mirror is 1.5 J/cm^2 for radiation on 1.06 μm at a pulse duration of 40 ns, and 12 J/cm^2 for radiation on 10.6 μm at a pulse duration of 200 ns. The authors were able to achieve lasing in a cavity formed by a flat and a concave polymer mirror with transverse discharge in CO_2. The most suitable base is 3 μm mylar. These film mirrors are easy to make, inexpensive and the parameters can be rapidly altered with considerable working areas. They should be competitive with conventional metal and glass mirrors. Figure 1; references 7: 6 Russian, 1 Western.
[95-6610

USSR UDC 530.145.61+530.182

QUANTUM RESONANCE FOR A ROTATOR IN A NONLINEAR PERIODIC FIELD

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249 No 5, 1979 pp 1103-1107 manuscript received 21 May 79

IZRAYLEV, F. M. and SHEPELYANSKIY, D. L., Institute of Nuclear Physics, Siberian Department, Academy of Sciences USSR, Novosibirsk

[Abstract] In studying the behavior of nonlinear quantum systems under the action of an external periodic perturbation, mathematical difficulties arise in theoretical analysis when the perturbations cannot be considered small. In previous numerical studies of a flat rotator subjected to delta-function impulses it has been found that the quantum system shows considerable difference from classical behavior when motion becomes stochastic. In particular, the rate of diffusion of the average energy of the rotator coincides with classical behavior only for limited times, and then drops sharply, even when the system is patently quasi-classical. In addition such a system shows a peculiar type of motion called quantum resonance, that has no analog in the classical system. In this paper it is shown that for quantum resonances in which the system is everywhere dense, the asymptotic dependence of rotator energy on time is universal and is described by a quadratic relation. This means that in resonance there is no quantum limit of stability as observed in the non-resonator case. It is also noted that there is no classical stability criterion even though the system may be patently quasi-classical. This quantum resonance effect may be useful in investigating the problem of rapid excitation of quantum systems by short laser pulses. The authors thank B. V. Chirikov for interest in the work and constructive criticism, G. M. Zaslavskiy, I. A. Malkin, V. V. Sokolov and S. A. Kheyfets for stimulating discussions, and also L. F. Khaylo for assisting with the calculations.
Figure 1; references 14: 9 Western, 5 Russian.
[86-6610]

USSR UDC 517.91/94:519.3

DETERMINING THE STRUCTURE OF GENERALIZED SOLUTION OF A NONLINEAR OPTIMUM CONTROL PROBLEM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 3, 1980 pp 525-528
manuscript received 9 Jul 79

VASIL'YEVA, A. B. and DMITRIYEV, M. G., Moscow State University imeni M. V. Lomonosov and Computer Center of the Siberian Department of the USSR Academy of Sciences, Krasnoyarsk

[Abstract] Investigation of pulses and special control sections that are optimum in the sense of Pontryagin's maximum principle by regularization of the input problem and subsequent asymptotic analysis by the method of boundary functions found during regularization of singularly disturbed problems can be applied to a class of nonlinear optimum control problems. Based on the sequential approach in the theory of generalized functions, the solvability of the nonlinear input problem of functional minimization in some set of generalized functions is established. A system of equations is derived to prove the proposed hypotheses. References 12: 10 Russian, 2 Western.

USSR UDC 517.946

THE SOLVABILITY OF THE NONLINEAR DIRICHLET PROBLEM IN A NARROW BAND

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 3, 1980 pp 569-573
manuscript received 9 Jul 79

SKRYPNIK, I. V., Institute of Applied Mathematics and Mechanics of the USSR Academy of Sciences, Donetsk

[Abstract] The existence of the classical solution of the Dirichlet problem for a general nonlinear elliptical equation in a narrow band is established. The condition of the narrowness of the band does not assume the smallness of the measure of this band since the measure of the band can be arbitrary. A series of equations is derived to prove the hypothesis. References 3 Russian.

USSR UDC 535.373

DIAGNOSIS OF THE MOLECULAR STATES OF CARBON DIOXIDE ACCORDING TO THE RESONANCE ABSORPTION OF CO_2 LASER RADIATION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249 No 6, 1979 pp 1353-1356
manuscript received 17 Jul 79

ACHASOV, O. V., LABUDA, S. A., SOLOUKHIN, R. I. and FOMIN, N. A., Minsk, Institute of Heat and Mass Transfer imeni A. V. Lykov, Belorussian SSR Academy of Sciences

[Abstract] Experimental data on the coefficient of resonance absorption in carbon dioxide in the 9.6 μm region were used to determine the Einstein coefficient of the transition $02^{0}1 \rightarrow 00^{0}1$ for the P20 line: $A_{21} = 0.16\ s^{-1}$. The experiments were performed with the aid of a CO_2 laser using an absorption "cell" represented by a CO_2 region that was uniformly compressed and heated by means of a shock wave. On this basis the possibilities for utilizing the processes of the resonant absorption of laser radiation by CO_2 as a means of diagnosing the molecular states of the gas are analyzed, considering by way of an example a method for determining the rotational (and hence also translational) and vibrational temperatures of the gas under inequilibrium conditions. A corresponding formula is presented. The theoretical findings are found to be in agreement with experiment. Figure 1; references 10: 5 Russian, 5 Western.
[87-1386]

USSR

DIFFUSION IN TOROIDAL TRAPS WITH REGARD TO ELECTRONIC ANOMALY

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 2, Jan 80 pp 88-92 manuscript received 3 Nov 79

YUSHMANOV, P. N., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] The increased transport in the tokamak by anomalous longitudinal electron viscosity is explained as equivalent to application of an additional poloidal pulse compared to neoclassical attenuation. A system of transport equations was found as the first step without regard to heat flux and thermal diffusion, which is explained as a rapid increase of the plasma pinch. The equations show that the diffusion flux and abnormal electron behavior vary within the range from neoclassical to pseudoclassical theory. A simple electron-ion plasma is used as the experimental model. Figures 2; references 5: 3 Russian, 2 Western.

USSR

THE CURRENT STRUCTURE OF A PLASMA FOCUS AT THE MOMENT OF FAST PARTICLE GENERATION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 2, Jan 80 pp 131-135 manuscript received 7 Dec 79

FILIPPOV, N. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] A complex structure of localized regions of fast electron generation in the mega-electron-volt range was found experimentally at the plasma focus during azimuth breakdown of the current shell. There is no relationship between the soft X-ray image of the axial discharge zone and the nature of spectral distribution of fast deuterons, but particle acceleration is related to dynamic dissipation of the magnetic field upon recombination of the magnetic lines of force. A direct relationship of current filmentation to fast particle generation in the mega-electron volt range at a plasma focus is indicated. The generated fast particles do not determine the neutron emergence from the plasma focus, but are the main cause of hard radiation generation from a linear Z-pinch. Figures 5; references 5 Russian.

USSR UDC 621.373.382.826

FLUORESCENT FIBER-OPTIC LIGHT CONCENTRATORS

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR - SERIYA FIZIKO-MATEMATICHESKAYA in Russian No 6, Nov/Dec 79 pp 32-35 manuscript received 27 Dec 78

AYTKHOZHIN, S. A. and AKANAYEV, B. A., Kazakh State University imeni S. M. Kirov, Alma-Ata

[Abstract] The parabolic, spherical or other rigid light concentrators used earlier were expensive structures requiring systems for tracking the sun. The use of fluorescent light collectors allows replacement of expensive semiconductor materials for energy conversion with cheaper plastic, dye-activated materials such as coumarin or glass activated with rare-earth elements. These materials absorb light over a broad range of wavelengths, then rerardiate in a narrow frequency interval, so that they can be selected to reradiate in the optimal range of frequencies of a semiconductor convertor. They are also capable of concentrating not only direct light but also diffuse, scattered light, so that sun-tracking systems are not necessary. This article describes two methods to avoid one significant shortcoming of fluorescent materials, related to their high level of natural absorption. One is by "drainage" of the light flux with optical fibers. Another is to construct optical fiber concentrators in several layers, covered with envelopes of various dyes selected so that each layer of fiber overlaps and converts a large portion of the light in the solar spectrum, collecting narrow-band radiation from each layer of fiber and sending it to a semiconductor convertor. A system efficiency of at least 35% can be achieved. Figure 1; references 6: 2 Russian, 4 Western.
[91-6508]

USSR

THE WIDTH OF SPECTRAL LINES IN A MOLECULAR NON-EQUILIBRIUM PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31 No 3, 5 Feb 80 pp 188-191 manuscript received 28 Dec 79

ZHUK, D. V., OTORBAYEV, D. K., OCHKIN, V. N., SAVINOV, S. YU. and SOBOLEV, N. N., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] A pressure-scanned Fabry-Perot standard crossed with a type DFS-8 monochromator was used to record the 2^+ radiation of the N_2 system in a discharge in a tube 20 mm in diameter with a discharge current of 20 mA in mixtures of N_2+He and N_2+Ar at a tube wall temperature of 77 K. Anomalous

expansion of spectral lines was discovered. It is concluded that this expansion results from nonresonant interactions among heavy particles, producing "hot" groups of molecules, for which the mean energy of rotary motion exceeds the thermal energy. Three possible mechanisms are suggested for formation of the "hot" groups of molecules. "Sorting" of electron-excited molecules of N_2 by velocities as a function of the energy of the coupled state is observed. Figures 2; references 3: 2 Russian, 1 Western.
[99-6508]

USSR UDC 681.883.677

STATISTICAL PROBLEM IN SYNTHESIS OF AN ANTENNA ARRAY

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26 No 1, Jan/Feb 80 pp 67-73
manuscript received 22 Jan 79

ZHUKOV, V. B.

[Abstract] The problem of improving the directional characteristic of antenna arrays by proper staggering of the elements is considered here, taking also into account fluctuations of the parameters of the medium. The directional characteristic is assumed to be given, the radiation pattern having been determined with random errors at every point in space. These errors are due to compounding of random errors in the distribution of vibrational velocity over the aperture and random inhomogeneities in the medium. The object is to determine the parameters of the statistical distribution of vibrational velocities over elements of the array which will yield the closest mean-square approximation to the given radiation pattern. This problem of antenna synthesis in operator form reduces to an Euler equation with a Lagrange multiplier acting as the regularization parameter, and is solved by the Rytov method of smooth perturbations. Typical results are shown for a linear array of 31 elements with a quarter-wavelength spacing. Figures 6; references 10 Russian.
[106-2415]

USSR UDC 519.25:681.142.2

SPIRAL SCANNING DATA TRANSMISSION PROGRAMS FOR THE BESM-6 COMPUTER AND THEIR CONVERSION TO FILTRATION-BLOCK FORMAT

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR - SERIYA FIZIKO-MATEMATICHESKAYA in Russian No 6, Nov/Dec 79 pp 78-82 manuscript received 8 Sep 78

SKOROBOGATOVA, V. I., YELUBAYEV, K. and LASAYEVA, P. YE., Institute of High Energy Physics, Kazakh SSR Academy of Sciences, Alma-Ata

[Abstract] A spiral measuring system consists of two devices and is used to measure the coordinates of tracks on bubble-chamber photographs. A control computer receives data from all units of the system, tests them and records the results of scanning on magnetic tape. Subsequent off-line processing requires programs which can convert data from the control computer format to the format of large computers. This article describes programs developed by the authors to convert data from the E-100 control computer format to the

intermediate format of the BESM-6 computer and then to the format for the filtration and calibration programs. The program is modular and is written in FORTRAN. Processing of bit-byte information is performed using a GENERAL SECTION subroutine, significantly expanding the capabilities of FORTRAN. Figures 4; references 4 Russian.
[91-6508]

6508
CSO: 1862

USSR UDC 534.12

WAVES IN A FINNED CYLINDRICAL SHELL IMMERSED IN A FLUID

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26 No 1, Jan/Feb 80 pp 84-90
manuscript received 23 Jan 79

KANDIDOV, V. P. and SHENYAVSKIY, L. A., Chair of Physics, Moscow State University imeni M. V. Lomonosov

[Abstract] The authors consider an infinitely long circular cylindrical shell with stiffening hoops and the effect of dynamic deformation of these hoops on the dispersion characteristics of the shell, this shell being immersed in an ideal fluid or, for comparison, making no contact with it. Assuming that the wave of resonant vibrations is longer than the period of the hoop array, so that the orothotropic model applies to this structure, the equations of elasticity in the linear approximation with negligible rotational inertia describe such a system. In the case of thin hoops their longitudinal vibrations are negligible relative to their flexural vibrations and the equation of motion can be solved accordingly. An analysis of the dispersion characteristic near resonances indicates the possibility of reducing the number of propagating modes as well as the amplitude of vibrations within certain frequency ranges by proper redesign of the hoops. Figures 5; references 8 Russian.
[106-2415]

USSR UDC 534.222.2

STRUCTURE OF THE FRONT OF A SHOCK WAVE IN A POROUS SOLID MEDIUM

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 106-114

DUNIN, S. Z. and SURKOV, V. V., Moscow

[Abstract] Propagation of shock waves through a porous solid medium is considered, assuming the width of the wave front to be much larger than the characteristic dimension of the cellular array. Any one porous cell of the body thus moves as an entity in the wave front while being compressed at the same time. The deformation process is analyzed, first in the case of an incompressible solid phase with only a change in porosity under pressure. A general equation describing the wave front structure in terms of the macroscopic porosity is then derived which applies to a generally viscoelastic

body and thus allows plastic flow of the solid phase to be taken into account between the two extremes of zero viscosity and zero inertia. The propagation of shock waves is found to be determined by the dependence of the pressure on the density as well as on its first and second derivatives with respect to time. The width of the wave front depends on the geometry of the porous space in the case of weak shock waves and also on the velocity in the case of strong waves. Figures 4; references 13: 7 Russian, 6 Western.
[105-2415]

USSR UDC 539.374

NUMERICAL SIMULATION OF COMPRESSION AND RAREFACTION WAVES IN METALS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5, Sep/Oct 79 pp 114-122 manuscript received 18 Sep 78

FOMIN, V. M. and KHAKIMOV, E. M., Novosibirsk

[Abstract] An isotropic medium is considered through which compression and rarefaction waves propagate, the state of such a medium being characterized by stress and strain tensors as well as a velocity vector and an internal energy. The strain-rate tensor here is the sum of two components representing elastic and plastic strain respectively. The propagation and the interaction of compression and rarefaction waves are described by the laws of mass, energy and momentum conservation, expressed here in Lagrange coordinates, and the closing equation of heat balance in additive form containing the Grueneisen parameter. These concepts are applied to strong shock waves in metals, as in the case of impact between two plates. The problem was solved numerically according to the Wilkinson difference scheme, assuming a deviator component of stress much smaller than the stress jump at the wave front and disregarding the thermal components at wave velocities below 4 km/s, on the basis of three different models of uniaxial deformation: the dislocation model, the hydrodynamic model, and the elastoplastic model with hardening. Depending on the impact parameters, and especially at higher wave velocities, all these models have yielded results in fair agreement with experimental data for aluminum, also copper, iron and lead. Figures 6; references 18: 11 Russian, 7 Western.
[105-2415]

USSR UDC 517.949.8:539.319

THERMOELASTIC STRESSES IN PIECEWISE-HOMOGENEOUS STRUCTURES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 135-143 manuscript received 28 Sep 78

BELEYCHEVA, T. G., Novosibirsk

[Abstract] Thermoelastic stresses in piecewise-homogeneous structures are analyzed, a radially and axially piecewise-homogeneous straight circular cylinder being selected as the mathematical model encompassing any number of different configurations. The problem is treated as a linearly elastic case with axial symmetry, assuming an absence of external forces and assuming temperature change to be uniform throughout this effectively compound cylindrical domain. With zero stresses at the outer surface and with continuity of stresses and displacements at the inner boundaries, the Duhamel-Neumann equations of equilibrium are reduced to variational form with respect to minimum potential energy of the system. The algorithm of the solution involves a finite-difference scheme with $O(h^2)$-order accuracy and a modular diagonal matrix to which the numerical method of successive upper linear modular relaxation is applicable. Calculation of stresses shown here for a model representing microelectronic devices with crystals mounted in a case. As a result of such a calculation with the best fitting cylinder configuration, radial and axial profiles of normal and tangential components of thermal stress are found in a typical system consisting of silicon and Polycore ferrite in boron-lead glass. The author thanks K. K. ZILING for the discussion. Figures 3; tables 3; references 26: 6 Russian, 20 Western. [105-2415]

USSR UDC 539.4

DEPENDENCE OF THE CRITICAL CONDITIONS IN BRITTLE FRACTURE ON THE INDENTER SURFACE GEOMETRY AND DIMENSIONS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 79 pp 143-150 manuscript received 23 Oct 78

KAGANOVA, I. M., Moscow

[Abstract] Brittle fracture under an indenter having a $z = Ar^{2\lambda}$ surface profile is considered, with the free energy and its derivative with respect to the crack length serving as criteria of transition from quasi-steady to unstable crack propagation. On the premise that the parameters of brittle

fracture are determined by the dependence of the contact area and thus of the contact stress on the indenter geometry under a given load force, by extension of the Hertz problem, the maximum pressure is calculated which develops under such indenters prior to fracture and found to be highest under a nearly conical one ($\lambda \rightarrow 1/2$). Data on spherical indenters can and should be used for practical estimates for the design of high-pressure equipment such as a Bridgeman anvil. The author thanks R. G. ARKHIPOV for having thoroughly familiarized himself with this study and having suggested changes resulting in a more comprehensible presentation, also B. V. VINOGRADOV, G. N. YERMOLAYEV, A. V. RAKHMANINA and YE. N. YAKOVLEV for the interest and helpful discussion. Figures 2; references 12: 7 Russian, 5 Western. [105-2415]

USSR

DYNAMIC BIREFRINGENCE IN A SUPERFLUID

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 31 No 3, 5 Feb 80 pp 191-193 manuscript received 29 Dec 79

ANDREYEV, A. F., Institute of Physical Problems, USSR Academy of Sciences

[Abstract] In a superfluid, two types of macroscopic movement are possible. Therefore, the dielectric permeability tensor may depend on the relative velocity. Birefringence appears, i.e., a difference in the dielectric permeability for light polarized along a vector relative to the velocity and in the perpendicular direction. A method is presented for calculating the birefringence constant. The effect in question is thermodynamically related to the appearance of anisotropy in the density of the normal component of the fluid in an external electric field. References 2 Russian.
[99-6508]

- END -

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25 April 1980

USSR REPORT

PHYSICS AND MATHEMATICS

No. 63

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SCIENTISTS DISCOVER SEMICONDUCTOR RECOMBINATION WAVE PHENOMENON

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 8 Mar 80 p 3

[Article by A. Valentinov, SOTSIALISTICHESKAYA INDUSTRIYA special correspondent: "Wave Rushes Through Crystal"]

> [Text] On 6 March a scientific discovery was registered under No 226 at the USSR State Committee for Inventions and Discoveries. "Phenomenon of Occurrence of Recombination Waves in Semiconductors" is the title of this scientific study authored by Doctors of Physics-Mathematical Sciences S. Kalashnikov, O. Konstantinov, V. Perel', and Candidates of Physics-Mathematical Sciences G. Tsarenkov, I. Karpova, B. Kornilov, and Yu. Zavadskiy.

Every metal melts in its own way. Germanium does this with aristocratic elegance, if we may phrase it in this manner. It initially incandesces white, and then an icy mirror appears in the crucible almost instantaneously -- a heavy liquid mass sparkling with a cold luster.

Irina Vladimirovna Karpova, staff member at the USSR Academy of Sciences Institute of Radio Engineering and Electronics, decided to acquaint me with the essence of this discovery, from the point of departure, as it were -- from the process of growing the semiconductor crystal itself. After it had cooled, it was cut up into small pieces. Contacts were soldered to the ends of one piece. Then the experiment proper began: the semiconductor was connected to a flashlight battery, and this circuit was connected to an oscilloscope. Wavy lines appeared on the oscilloscope screen.

This made no impression on me. Irina Vladimirovna hastened to explain: "We have applied direct current to the semiconductor, and yet a pulse signal has appeared on the oscilloscope. This means that the crystal has been transformed into a alternating-current generator. Herein lies the essence of our discovery...."

At this point we must recall the universally-known fact that electric current is the movement of electrons. But in semiconductors there is movement, in addition to electrons, of... "holes."

"Holes" is a term in physicist's jargon. In actual fact it is approximately the same as a hole in a doughnut -- an empty place from which an electron has just "departed." Nevertheless these empty spots move through a semiconductor, just as electrons, but in the opposite direction. And most important, just like electrons, they have their own... "lifetime."

Leningrad theoretical physicists O. Konstantinov, V. Perel', and G. Tsarenkov advanced the hypothesis that under the most ordinary conditions semiconductors can generate alternating current. But for this it is necessary that the "lifetime" of electrons and "holes" differ greatly from one another. How can this be accomplished? The Leningrad scientists proposed doping the semiconductor with certain substances. At this stage Moscow scientists joined the project. At the Institute of Radio Engineering and Electronics they worked with germanium, and at the Pulsar Scientific Research Institute -- with silicon. Through their joint efforts the scientists were able to prove the correctness of the theory. In addition they found doping materials which "exhibit" new properties of semiconductors. In 1968 they reported this newly-discovered phenomenon at an international conference. Why is the discovery only now being registered?

"We spent so many years looking for facts which would not fit into the proven theory," stated Candidate of Physics-Mathematical Sciences B. Kornilov.

"Have you found them?" "Not yet...."

But these years did produce results: the obtained semiconductor materials have proven indispensable as highly-precise tracers. They reacted to negligible changes in magnetic field, light flux, pressure, temperature, and shower of charged particles. And this meant that science, technology and industry can produce highly sensitive sensors monitoring the most subtle processes. And add to this the possibility of building devices which can convert light, electrical and mechanical signals into electromagnetic.
[130-3024]

3024
CSO: 1862

USSR UDC 531.383

AN EXACT SOLUTION OF THE PROBLEM OF THE MOTION OF A GIMBALED GYROSCOPE

Moscow DOKLAY AKADEMII NAUK SSSR in Russian Vol 250 No 4, 1980 pp 823-825
manuscript received 17 Jul 79

KHARLAMOV, M. P., Donetsk State University

[Abstract] A gyroscope with design flaws is considered. Such flaws are taken into account in, e.g. the analysis of drift. An exact solution of the problem of the motion of this gyroscope in gimbals, is presented on the basis of A.A. Bogoyavlenskiy's indication of the conditions for separation of variables in the case in which the axis of an unbalanced gyroscope is horizontal (expressing the time dependence of the principal variables by means of elliptical functions). To this end, a system consisting of three bodies (outer ring, inner ring, and rotor) is examined in specific inertial frames. It is shown that the configuration of the system is determined by three Lagrangian coordinates. Formulas for the kinetic energy and potential energy of the system are presented. It is shown that the entire possible range of permissible values of the integration constants k, yields 16 different types of trajectories in the configuration space. These types can be readily described qualitatively. References 10 Russian.
[103-1386]

USSR UDC 548.736.6

CRYSTAL STRUCTURE OF $Cd(CH_3COO)_2 \cdot 2CSN_2H_4$

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 4, 1980 pp 852-854 manuscript received 21 Sep 79

BONDAR', V. I., RAU, V. G., STRUCHKOV, YU.T., AKIMOV, V. M., MOLODKIN, A. K., ILYUKHIN, V. V. and BELOV, N. V., Vladimir State Pedagogical Institute imeni P. I. Lebedev-Polyanskiy

[Abstract] The structure of the Cd-polyhedron and of the compound $Cd(CH_3COO)_2 \cdot 2CSN_2H_4$ as a whole was investigated by means of x-ray structural analysis, using the Paterson method with subsequent construction of δ'-synthesis. Reflections were observed with the aid of the Syntex $P2_1$ MoK diffractometer. The parameters of the crystal structure of rhombic $Cd(CH_3COO)_2 \cdot 2CSN_2H_4$ were found to be: $a = 11.805 \pm 0.002$, $b = 15.438 \pm 0.003$, $c = 7.582 \pm 0.002$ Å. The resulting values of atomic coordinates and their anisotropic (isotropic for hydrogen atoms) thermal corrections are tabulated, as are the principal interatomic distances and angles in discrete fragments of the structure. Judging from the results of structural analysis, this compound can be assigned either the coordination number 4 with the nearest tetrahedral surrounding of the atoms of S, S', O_1 and O_1', or the coordination number 6 ("twin-capped" tetrahedron) with inclusion of the atoms of O_2 and O_2' in the coordination tetrahedron. Figures 2; references 9: 4 Russian, 5 Western. [103-1386]

USSR UDC 621.315.592

INVESTIGATION OF PHONON-PHONON RELAXATION IN NEUTRON-DOPED AND ORDINARY SILICON CRYSTALS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 14 No 2, Feb 80 pp 302-305 manuscript received 26 Jun 79

BARANSKIY, P. I., SAVYAK, V. V. and SHCHEBRINA, L. A., Institute of Semiconductors, Academy of Sciences UkrSSR, Kiev

[Abstract] Experience has shown that silicon crystals doped with ^{31}P by transmutation of ^{30}Si atoms under thermal neutron bombardment have higher homogeneity of dopant distribution and higher values of mobility than crystals doped by adding phosphorus to the melt. The authors examine the question of whether neutron-doped silicon crystals show similar advantages over ordinary crystals with respect to criteria involving scattering of phonons rather than electrons, which is equivalent to an improvement in the resolution of

scatters (defects), since the de Broglie wavelength of even the longest-wave phonons is shorter than the electron wavelength. The analysis is based on a study of phonon-phonon relaxation at T = 85 K in terms of the theory of anisotropic scattering. Experimental data are used that were obtained by measuring the piezothermo-emf as a function of magnetic field strength in the electron-phonon drag region in n-Si neutron-doped crystals. It is shown that residual defects that arise with transmutation doping have no noticeable effect directly on the electron subsystem, and cause a considerable change in effects that involve long-wave phonons. The authors thank A. G. Samoylovich for discussing the results. Figures 2, references 7: 3 Russian, 4 Western.
[128-6610]

USSR UDC 621.315.592

ON THE NATURE OF p-n CONVERSION OF ION-BOMBARDED InSb CRYSTALS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 14, No 2, Feb 80 pp 306-310 manuscript received 26 Jun 79

BLAUT-BLACHEV, A. N., GERASIMENKO, N. N., LEZHEYKO, L. V., LYUBOPYTOVA, YE. V. and OBODNIKOV, V. I., Institute of Physics of Semiconductors, Siberian Department, Academy of Sciences USSR

[Abstract] An investigation is made of the behavior of conductivity and effective mobility at 77 K in layers of p-InSb subjected to bombardment with ions of Ne^+, Ar^+ and Kr^+. The initial material was doped with Cd, Zn or Ge. It was found that irradiation with inert ions at 250-300°C, or at room temperature with subsequent annealing at 250-300°C produces a layer of n-type conductivity only in germanium-doped InSb with a hole concentration of the order of 10^{14} cm^{-3} or less, and that p-n conversion does not occur at all when the initial material is doped with Cd or Zn. It is concluded that ion bombardment combined with heat treatment produces structural changes that alter the electrical state of the amphoteric dopant, causing p-n conversion. The depth of the converted layers depends on the state of the surface, and in particular on the type of coating. Figures 2, references 11: 8 Russian, 3 Western.
[128-6610]

USSR

DIELECTRIC SPECTRA OF KDP-DKDP MIXED CRYSTALS IN SUBMILLIMETER RANGE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 11, 1979 pp 3304-3309 manuscript received 29 May 79

VOLKOV, A.A. and KOZLOV, G.V.

[Abstract] Frequency dependence of dielectric permeability in the region of fundamental dispersion is a major source of information on the mechanism responsible for phase transitions in ferroelectric crystals. Temperature-unstable lattice vibrations at the phase transition temperature lead to spontaneous polarization in the crystal. In conformity with the anomalous temperature behavior of the ferroelectric soft mode, the region governed by its dispersion also shifts toward the lower frequencies. In mixed crystals, the frequency of ferroelectric modes falls anomalously at the phase transition temperature. Typical dispersion frequency of transverse dielectric permeability also drops with a rise in the degree of deuterization. References 20: 5 Russian, 15 Western.
[92-8617]

USSR UDC 548.55

USE OF SAPHIRE TUBES PRODUCED BY THE STEPANOV METHOD AS ENVELOPES FOR LASER PUMPING LAMPS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 44, No 2, Feb 80 pp 386-388

SAPRYKIN, L. G., BRAILOVSKIY, V. B., GAYDUKOV, YE. N., YEGOROV, L. P., ZATULOVSKIY, L. M., KRAVETSKIY, D. YA., LEONOV, G. S. and RYZHKOV, A. YE.

[Abstract] The best pumping sources for YAG-Nd lasers are based on discharge in alkali metal vapors. Since alkali metals attack quartz glass, the envelopes for alkali vapor arc lamps are made of alumina. Polycrystalline aluminum oxide has diffusing properties that are determinental to focusing, and hence reduce the efficiency of the laser pumping system. Suitable envelopes for pumping lamps are now being made by drilling, grinding and polishing single crystal Al_2O_3 rods grown by the Czochralski method. In this paper the authors study the feasibility of using sapphire tubes grown by the Stepanov method as lamp envelopes. The equipment and technique used for growing the tubes are described in a previous article [see L. P. Yegorov, L. M. Zatulovskiy, D. Ya. Kravetskiy et al., IZV. AN SSSR: SER. FIZ., Vol 42, 1979, p 1947]. The tubes were 4.6 and 7 mm in diameter with walls 0.5, 0.75 and

1.0 mm thick. Growth rate was 2 mm/min, and inside and outside diameter were held within a tolerance of 0.1 mm. The tubes were annealed and used as envelopes without further mechanical or chemical treatment. The lamps were filled with Xe-K-Rb and niobium caps were sealed on the ends with $CaO-Al_2O_3-MgO$ cement. Comparative tests show that the apparent diameter of the arc with sapphire envelopes is at least 1.5 times smaller than for a polycrystal alumina envelope. This is in agreement with envelopes made by drilling out single crystals of Al_2O_3 grown by the Czochralski method. Figures 2, references 6: 4 Russian, 2 Western.
[126-6610]

USSR UDC 548.55

USING SHAPED SINGLE CRYSTALS IN FLASHTUBE PUMPING SYSTEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 44, No 2, Feb 80 pp 389-392

BALASHOV, I. F., BEREZIN, B. G., BUCHENKOV, V. A., YEVDOKIMOVA, V. G., YEGOROV, L. P., ZATULOVSKIY, L. M., KRAVETSKIY, D. YA., POLYAKOV, M. I., STEPANOV, A. I. and KHANKOV, S. I.

[Abstract] Flashtube pumping systems for stimulating the active medium of solid-state lasers frequently use parts of complex configuration made of transparent material. These monoblocks are ordinarily used in lasers with forced cooling by fluid flowing in channels through the illuminator. It is shown that natural heat transfer can be used in such pumping systems when the illuminator is made from a single crystal of a material with a high coefficient of thermal conductivity such as leucosapphire, magnesite, garnet, beryllium oxide and so on, thus considerably reducing the temperature of the active medium. The proposed method of heat reduction is based on the increased effective coefficient of heat transfer from the active element to the ambient medium when the heat source is provided with fins. Leucosapphire is hard to machine, and for certain shapes of monoblocks, it is practically impossible to use conventional machining techniques. The authors have used the Stepanov method to grow monoblocks for flashtube pumping systems with natural heat transfer. Crystals of high optical quality were grown with diameter of up to 28 mm. The openings in the monoblock for the flashtube and active element were 8.5 mm in diameter. Maximum length was 220 mm. The margin of accuracy for the shape of the holes was 0.1 mm, and for the outside diameter of the monoblock the accuracy was 0.1-0.2 mm. The growth rate must be held to 0.5mm/min or less to ensure satisfactory transparency. Thermal stresses were kept low by using special measures to ensure a low temperature gradient in the crystallization zone. The monoblocks produced in this way did not crack when cut, even without annealing. Surface quality was good enough for use in

lasers without further mechanical or chemical treatment. Sapphire monoblocks grown as a single crystal give a gain in maximum pumping power of a factor of about 10 as compared with tubular illuminators. Figures 2, references 4 Russian.
[126-6610]

USSR UDC 548.55

USING SINGLE CRYSTAL TUBES FOR TEMPERATURE BALANCING IN THE ACTIVE MEDIUM OF A SOLID-STATE LASER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 44, No 2 Feb 80 pp 393-396

BALASHOV, I. F., BEREZIN, B. G., YEGOROV, L. P., ZATULOVSKIY, L. M., KRAVETSKIY, D. YA., PIS'MENNYY, V. A., POLYAKOV, M. I. and KHANKOV, S. I.

[Abstract] One of the simplest ways to reduce temperature imbalance in the active element of a solid state laser is to enclose it in a transparent tube with high thermal conductivity. It is shown that the optimum material for such a tube is single crystal leucosapphire. Since this material is not easily machinable, the authors propose growing the tubes from the melt by the Stepanov method. Tubes were grown by this method with diameters ranging from 6 to 20 mm, and wall thickness from 0.5 to 4.0 mm. These tubes were annealed and used in neodymium-doped and YAG lasers without further mechanical or chemical treatment. For an average pumping power of about 25 W these sapphire tubes effectively stabilize emission energy, reducing the wedge deformation and temperature of the active element, and enabling continuous operation for about 3 minutes. Figures 3, references 8: 7 Russian, 1 Western.
[126-6610]

USSR UDC 532.63

THE CZOCHRALSKI-STEPANOV METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 44, No 2, Feb 80 pp 397-399

PANKOV, V. M.

[Abstract] The author considers the process of crystal growing by the Czochralski method when the ratio of crystal diameter r to crucible diameter R is close to unity. Analysis of the stability of the crystallization process

shows that the Czochralski method begins to acquire the features of the Stepanov method when $r/R \sim 1$, the overall stability of the crystallization process being maintained due to capillary stability. It is shown that in this case the overall stability is intensified by an increase in one of the coefficients in the thermal equation. Intensification of stability of the crystallization process will become appreciable at low temperature gradients within the crystal. As the crystallization front moves into the heater cavity, the temperature gradient in the crystal must be considerably reduced. The deterioration of thermal stability of the process due to the reduced temperature gradient in the crystal will be compensated by the large value of r/R. This technique is called the Czochralski-Stepanov method. For comparison, crystals of silicon were grown by the Czochralski method with average diameter of 41 mm from a crucible 135 mm in diameter and 60 mm high with a charge of 1.5 kg, and by the Czochralski-Stepanov method with average diameter of 35 mm from a crucible 40 mm in diameter and 150 mm high with a charge of 0.37 kg. The maximum deviation from the average diameter for the Czochralski crystals was ± 1.5 mm, and for the Czochralski-Stepanov crystals -- ± 0.3 mm. Figure 1.
[126-6610]

USSR UDC 548.552

FORMATION OF DEFECT STRUCTURE IN SHAPED CRYSTALS OF OPTICAL CORUNDUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 44, No 2 Feb 80 pp 400-403

MUSATOV, M. I., NIKOLAYEV, I. N., PETUNINA, I. N. and IVANOV, B. G.

[Abstract] Corundum single crystals grown by the Stepanov method have limited applicability due to low quality. The main defects in these crystals are blocks, relatively high dislocation density and gas inclusions. The authors investigate the causes of blocks and dislocations in optical corundum crystals. It is shown that the block structure forms only when the optical axis is perpendicular to the direction of crystal pulling and to the plane of plates grown by the Stepanov method. This is attributed to the coincidence of the directions of action of stresses due to temperature gradients and the directions of possible slipping along prisms of the first and second kinds. Conditions are determined for growing crystals of zero orientation without block defects by the Stepanov method. It is shown that dislocations are formed mainly along slip planes in regions with high stresses. Diffusion processes play a part in the formation of both blocks and dislocations. A comparison of the conditions of growth of corundum crystals of zero orientation by different methods shows that the rates of diffusion of vacancies in the crystal lattice are different in different directions. Figure 1, references 11 Russian.
[126-6610]

USSR UDC 539.375.5

CRACK PROPAGATION UNDER THE ACTION OF AN ELECTROMAGNETIC FIELD

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 5, 1980 pp 1096-1100 manuscript received 7 Jul 79

PARTON, V. Z., KUDRYAVTSEV, B. A. and RUBINSKIY, B. D., Moscow Institute of Chemical Machine Building

[Abstract] The effect of the electromagnetic field on the processes of deformation and heat conduction in a crack in a metal specimen is theoretically investigated for an unbounded plate of a current-conducting material in which there instantaneously arises a semiinfinite nonconducting crack located along the negative semiaxis $x \leqslant 0$, $y = 0$. Formulas for the intensity vectors of electrical and magnetic fields are presented, as is a formula for the perturbation of the magnetic field due to the presence of the crack. The temperature state of the crack is derived from the quasistatic formulation of the related thermoelasticity problem. Corresponding formulas for the stressed state indicate that in the neighborhood of the crack apex there arise compressive thermal stresses which may inhibit the propagation of a crack developing under the action of specified mechanical loads. It is thus shown that the instantaneous formation of a crack in a current-conducting plate results in the fusion of the crack apex with the formation of a microcrater which reduces the concentration of mechanical stresses, owing to the attendant increase in the radius of curvature of the crack apex. Figure 1; references 7 Russian.
[119-1386]

USSR

PHOTOINDUCED CHANGE IN MAGNETIZATION OF $CdCr_2Se_4$ MAGNETIC SEMICONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 21, No 11, 1979 pp 3250-3254 manuscript received 16 Apr 79

RUDOV, S.G. and VESELAGO, V.G., Physics Institute imeni P. N. LEBEDEV, USSR Academy of Sciences, Moscow

[Abstract] Interaction of electronic and magnetic subsystems causes cross magnetic-optical-electrical effects in magnetic semiconductors. Photoexcitation of electrons in nondegenerate antiferromagnetic semiconductors may convert them to the ferromagnetic state. Magnetic semiconductor $CdCr_2Se_4$ undergoes photoinduced changes in magnetic properties. Intense laser emission

alters its magnetization. Chips with natural facet (111) 1 x 2.5 mm in size were measured; their thickness ranged from 0.3 to 1 mm. Deviation of magnetization from the stationary direction under the influence of exciting pulses is maximum in the absence of a magnetic field which stabilizes the direction of spin momentum. In the region of disappearance of the domain structure, the magnetic field inside the specimen differs from zero, and the S2 signal falls to inverse proportion to internal magentic fields. References 14: 10 Russian, 4 Western.
[92-8617]

USSR UDC 532.529

PREFERRED WAVE NUMBERS OF TWO-DIMENSIONAL PERTURBATIONS IN THE PROBLEM OF CONVECTION IN A HORIZONTAL LAYER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 4, 1980 pp 826-829
manuscript received 26 Jul 79

GETLING, A. V., Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov

[Abstract] Thermal convection in a plane horizontal layer of a fluid heated from below is known to be characterized by a quasi-two-dimensional flow in the form of billows. The horizontal width distribution of these billows displays a maximum corresponding to some preferred width, or "preferred" wavelength. In this connection, the isolation of a preferred mode of convection from initial "noise" is investigated by considering a nonlinear problem with a continuous spectrum of perturbations and assuming that initially the velocity and temperature fields contain all possible wave numbers, including zero. Coordinate representations of solutions derived by the inverse Fourier transform are used to investigate the process of the formation of convective billows and to determine their wave numbers. A table is given of preferred wave numbers corresponding to the periodicity of steady-state billows generated by initial perturbations in the presence of 7 different values of Rayleigh and Prandtl numbers. It is shown that the preferred wave number decreases with increase in the Rayleigh number from 660 to 10^4, particularly in the presence of low Prandtl numbers. This effect may be attributed to the intrinsic properties of the mechanism of convection in an infinite horizontal layer. Figure 1; references 10: 2 Russian, 8 Western. [103-1386]

USSR UDC 533.6.011.32

LINEAR VORTEX THEORIES OF AIRFOILS AND WINGS WITH AIR SCOOPS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 4, 1980 pp 829-833
manuscript received 18 Jul 79

SHURYGIN, V. M.

[Abstract] The linear problem of flow around a slender airfoil with an air intake is examined in the approximation of a flow around a flat plate from a source located on the plate at the point $x = x_A$, where the air intake is located. The problem is subdivided into symmetrical and antisymmetrical problems. A formula for the intensity of the vortex layer originating from the source is presented. It is shown that, with the exception of the first and last vortices, discrete vortices form in areas of the vortex layer positioned

symmetrically in relation to the vortex for slender airfoils, and that this also applies to finite-span wings with air intake. The resulting principle of construction of the original vortex layer is based on a continuation of the vortex lines in the form of lines aligned along the incident flow. The rules of similarity that generalize the linear theory of flow around airfoils with an air intake to transonic velocities are readily applied to finite-span wings if allowance is made for the variation in aspect ratio with variation in Mach number. Figures 2; references 5 Russian.
[103-1386]

USSR UDC 534.28

EFFECT OF COMPRESSIBILITY ON THE VORTICAL TURBULENCE SPECTRUM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 4, 1980 pp 849-851
manuscript received 3 Oct 79

MOISEYEV, S. S., TUR, A. V. and YANOVSKIY, V. V., Khar'kov Physico-Technical Institute, UkrSSR Academy of Sciences

[Abstract] The properties of strong turbulence in hydrodynamics and plasma are chiefly interpreted on the basis of the Kolmogorov-Obukhov theories of the spectral constancy of the energy flux P_k, so far as imcompressible fluids are concerned. Considering that compressible fluids represent another extreme, the effect of compressibility on the vortical component of turbulence in the presence of low Mach numbers is examined. It is shown that in the presence of relatively low compressibility the turbulence spectrum loses its self-similar nature owing to the effect of the Mach number. It also is shown that the violation of the Kolmogorov self-similarity principle is then due to the Mach number dependence of the energy density in wave number space. A corresponding formula for the vortical energy spectrum of compressible fluids at $M^2 \leq 1$ is derived. References 9 Russian.
[103-1386]

USSR UDC 536.27

CONVECTIVE-FILM COOLING OF TURBINE NOZZLE VANES

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 6, Nov Dec 79 pp 1319-1327 manuscript received 14 Jul 78

ZIKEYEV, V. V., Moscow

[Abstract] The efficiency of convective or film cooling in gas turbines is determined not only by the maximum gas temperature that can be reached for given coolant and vane temperatures and by the required relative flowrate of air, but also by the extent of gasdynamic ideality of the system. Injection of air to produce the film involves additional energy losses between vanes. The general recommendation is to use convective cooling, and supplement it with film cooling in case of extreme necessity. In convective cooling the greatest difficulties arise in organizing cooling of the trailing edge of the vane because of the high heat fluxes from the gas and the reduced cooling capacity of the air that has been preheated by the leading edge. This may make it necessary to use convective-film cooling in this case. The author derives analytical relations for calculating the efficiency of convective-film cooling based on a heat sink model, assuming that velocity in the boundary layer changes according to a power law with exponent n = 1/12. The results show good agreement with experimental data obtained in testing film cooling of gas turbine nozzle blades in situ. Figures 4, references 22: 11 Russian, 11 Western.
[101-6610]

USSR UDC 532.517.2

UNSTEADY BOUNDARY LAYER OF A PLATE WITH TIMEWISE INTERMITTENT SUCTION

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA - MATEMATIKA-MEKHANIKA-ASTRONOMIYA in Russian No 13, Jul 79 pp 71-74 manuscript received 18 Apr 78

BEL'DEY, L.M. and KULONEN, L.A.

[Abstract] A flat plate is positioned in a plane parallel flow of a viscous incompressible fluid at a zero attack angle, and the plate extends downstream without limit. A uniformly distributed suction is suddenly applied to the surface at some point in time, and then removed just as suddenly at another time. It is assumed that the fluid or gas flowrate is small, the physical properties of the medium do not depend on the temperature, that the suction velocity normal to the plate is constant along the surface and is a timewise

step function. The problem of determining the nature of the change in the frictional stresses at the surface of the plate as a result of the intermittent suction is solved through a Fourier analysis of the basic nonsteady-state laminar boundary layer flow equation. Figures 2; references: 2 Russian [104-8225]

USSR UDC 533.6.011.8

A VARIANT OF THE ENSKOG-CHAPMAN METHOD APPLIED TO A BOUNDARY LAYER WITH FAST AND SLOW RELAXATION PROCESSES

Leningrad VESTNIK LENINGRADSKOGO UNIFERSITETA - MATEMATIKA-MEKHANIKA-ASTRONOMIYA in Russian No 13, Jul 79 pp 87-93 manuscript received 25 Mar 78

NAGNIBEDA, YE.A. and LAPTEV, V.A.

[Abstract] The example of flow around a flat-semi-infinite plate is used to illustrate a modification of the Enskog-Chapman procedure for a boundary layer in a reacting mixture of gases with internal degrees of freedom. A method proposed in earlier literature for a simple gas is used to derive a system of transport equations and the formulas for the calculation of the flow terms in a first approximation. The detailed mathematical treatment starts with the introduction of the defining macroparameters in terms of the numerical densities of the various kinds of particles, their velocity, the mass velocity components and the temperature, subsequently utilizing the Enskog-Chapman procedure to find the time derivatives of these macroparameters and ultimately arrive at expressions in a viscous approximation for the stress tensor and the heat flux. It follows from the derived formulas that in a first approximation, the presence of internal degrees of freedom has no influence on the rate of diffusion and the stress tensor components, while the component of the heat flux vector in the direction of the y-axis (specified in the earlier literature) changes, as compared to a mechanical mixture of gases, due to the heat flux resulting from the transport of the energy of the internal degrees of freedom. References: 6 Russian.
[104-8225]

USSR UDC 532.20

ON THE HYDRODYNAMICS OF STRUCTURAL RELAXING FLUIDS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA - MATEMATIKA-MEKHANIKA-ASTRONOMIYA in Russian No 13, Jul 79 pp 94-98 manuscript received 27 Apr 78

SKVORTSOV, G.YE.

[Abstract] The formulation of a structural relaxation theory of hydrodynamics which describes the flow of fluid media of diverse classes in a wide range of conditions is broken down into three stages: the derivation of the fundamental closed system of equations and its general analysis; ascertaining the general functional form of the defining relationships and the formulation of the principles promoting their precise specification; the specification of the defining relationships with the utilization of general principles and experimental data. The paper is a general mathematical treatment of this theory which takes into account such phenomena as nonlinearity, retardation and nonlocality. The general analytical expressions adduced must be given a specific form depending on the various classes of fluids, an extremely complex problem which is to be solved semi-phenomenologically. The theory is promising for the description of turbulent fluid and complex fluid media flows, for the analysis of high intensity shock aves and explosive processes, as well as low amplitude processes in a full range of velocities and gradients, for the purpose of ascertaining the structure of the media. The general theory is illustrated for the specific case of a molecular gas, where the starting point is linearized equations for the mass balance, momentum and relaxation quantities: the specific energies of the translational and internal degrees of freedom. Specific analytical expressions are derived in this case for a monatomic gas and it is shown that the medium has six space-time scales; the characteristics of the structural kinetic components forming the medium are found from an analysis of the zeros of the governing function derived. This general theory was first presented in reports to a seminar on mechanics of the mathematical mechanics department of Leningrad State University on 17 June 1976 and 3 March 1977. References 4: 3 Russian, 1 Western.
[104-8225]

USSR UDC 533.6.011

A COMPARISON OF ASYMPTOTIC AND NUMERICAL RESULTS IN A THEORY OF HYPERSONIC FLOW AROUND BLUNTED SOLIDS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA - MATEMATIKA-MEKHANIKA-ASTRONOMIYA in Russian No 13, Jul 79 pp 118-120 manuscript received 9 Dec 78

ENGEL'GART, V.N.

[Abstract] An asymptotic interation procedure is employed to find the analytical solution of the steady-state problem of hypersonic flow around blunted solids in an ideal gas. The contours of the solids considered here are specified in the form of a power series; the asymptotic solution is compared with numerical calculations performed in earlier literature. The Mach number of the incident flow is taken as infinity and the ratio of the specific heats approaches unity. Data given in tabular form illustrate the range of validity and the efficiency of the asymptotic expansion used to calculate the pressure on an airfoil and the separation of the shock wave from it. References 8: 7 Russian; 1 Western.
[104-8225]

USSR UDC 621.378.33

THE ELECTRICAL DISCHARGE CHARACTERISTICS OF A PULSED CO_2 LASER

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 95 No 3, 1979 pp 569-572 manuscript received 4 May 79

BARKHUDAROV, E.M., BEREZOVSKIY, V.R., GELASHVILI, G.V., PETRUSHEVICH, YU.V., TAKTAKISHVILI, M.I. and CHELIDZE, T.YA., Institute of Physics of the Georgian SSR Academy of Sciences

[Abstract] Theoretical results computed for the discharge voltage and current, radiation output and concentration of electrons are compared with experimental results obtained using a pulsed CO_2 laser with double transverse discharge. The length of the semi-confocal resonator of the laser was 5 m and the active region was 3 m long. The ratio of the constituent gases, CO_2:N_2:He, was varied and the pressure in the 8.4 liter discharge volume ranged from 100 to 400 torr. A maximum output energy of 180 J was found for a mixture of CO_2:N_2:He = 2:2:3 at 400 torr, and the specific output energy in this case was about 44 J/l•atm. The system of differential equations used to describe the behavior of the concentration of electrons and ions, the gas temperature and the symmetric, antisymmetric and deformation modes of the CO_2 molecules as well as the N_2 vibrations are not shown, but it is indicated that they were supplemented with equations describing the behavior of the power supply circuit. Typical of the agreement between the theory and experiment are values for a mixture ratio of 3:3:4 where the output energy was 120 J (experimental) and 180 J (calculated). Reasons for the disparities are: the entire volume occupied by the discharge is not efficiently utilized; also, the calculated results depend a great deal on the values of the ionization and sticking coefficients, and the nature of their dependence on the ratio of the field intensity in the discharge to the concentration of neutral molecules. The greatest divergence was found in the computed time for the output pulse delay with respect to the current maximum, which was smaller than the experimental value by a factor of two to three. It is noted that this disagreement and others can be related to an entire series of processes which are not considered in the formulation of the equations. Still, the proposed system of equations can be used to calculate the parameters of a CO_2 discharge laser by adding a term describing the ionization due to the electron beam to the equation for the electron concentration. Figures 1; references 7: 3 Russian; 4 Western.
[102-8225]

USSR UDC 533.932

EMISSIVE CHARACTERISTICS OF XENON IN RAREFIED PLASMA

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17 No 5, 1979 pp 916-921 manuscript received 11 Apr 78

BUGROVA, A. I., YERMOLENKO, V. A. and KALIKHMAN, L. YE., Moscow

[Abstract] The absolute intensities of the spectral lines representing the emission spectrum of rarefied xenon plasma in crossed electric and magnetic fields were measured by calibrating them with respect to a standard source with a known absolute luminance. On the basis of these measurements the luminous energy emitted by the plasma within the optical wavelength range was estimated at 2-3 W in the source channel. It is shown that the population of the upper energy levels in the plasma is satisfactorily described by the coronal equilibrium model, and that knowledge of the absolute intensity of a line and of the optically determined electron temperature makes it possible, within the framework of the coronal model, to compute the product of the atom concentration and the electron concentration; given a known electron concentration, this provides an idea of the atom concentration in a given source. Figures 5; references 17: 13 Russian, 4 Western.
[107-1386]

USSR UDC 536.24

INVESTIGATION OF HEAT TRANSFER IN THE ACTIVE-ELEMENT CHANNEL OF SOLID-STATE LASERS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17 No 5, 1979 pp 1061-1063 manuscript received 5 Dec 78

GENIN, L. G., KUZNETSOV, S. M. and SAYENKO, D. V., Moscow Energy Institute

[Abstract] The properties of the radiation generated by solid-state lasers are adversely affected by the heating of their active elements. This necessitates the use of cooling systems. In this connection heat transfer from the surface of the active element was experimentally investigated with respect to a water-cooled laser in which the active element was replaced by a stainless steel tube through which electrical current was passed. The range of Reynolds numbers considered varied from $2 \cdot 10^3$ to $14 \cdot 10^3$. The experimental data were used to derive a formula for the Nusselt number distributions as well as a formula for computing the heat transfer coefficients in the lamp channel and in the active-element channel of solid-state lasers with unit-body reflectors. These formulas are recommended for computing heat transfer from active elements and pumping lamps of this type of laser for the Reynolds number range considered. Figures 2; references 3 Russian.
[107-1386]

USSR UDC 538.4:532

INSTABILITY OF A CONDUCTING VISCOUS FLUID LAYER SURROUNDING A SOLID ROD

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 4, 1979 pp 24-28 manuscript received 25 Apr 79

PRUDNIKOV, V. V.

[Abstract] Stabilization of MHD instabilities serves to introduce into a conductor sufficient energy to achieve a rapid and uniform vaporization of the conductor surface. In this section, axisymmetric perturbations of a layer of viscous fluid with current flowing along its surface are analyzed in linear terms. The small-perturbation method is used to formulate the corresponding dispersion formula, from which estimates of the increment of instability in the presence of low and high wave numbers are derived. These estimates point to the existence of a certain wave number at which that increment is minimal. In both cases (low and high wave numbers) the increment is directly proportional to the square of current intensity, inversely proportional to viscosity, and independent of density. At high wave numbers this increment is also independent of the layer thickness (coincides with the Taylor estimate for a compressible viscous fluid column with surface current). References 6 Russian.
[108-1386]

USSR UDC 533.92

DISCHARGE CONTRACTION IN A MOLECULAR ELECTRONEGATIVE GAS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 17, No 6, Nov Dec 79 pp 1153-1160 manuscript received 23 Jan 79

BYCHKOV, V. L. and YELETSKIY, A. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Previous research on discharge contraction in electronegative gases has shown that the transition from vibrational to translational energy accompanying the discharge causes sharp temperature inhomogeneity in the discharge column. Continuing this research, the authors study the influence that exchange of energy between translational and vibrational degrees of freedom of molecules has on the mechanism and nature of contraction in molecular electronegative gases. An approximate method is worked out for simultaneous solution of the equation of balance of vibrational and translational energy and the equation of balance of charged particles with consideration of the way that ionization efficiency, sticking and neutralization of charged

particles depend on radius. The technique is based on the weak functional dependence between the solutions of these equations. The solution takes the form of a simple radial dependence with a single variable parameter that characterizes the scale of the drop in the unknown function from the axis toward the walls of the discharge tube. Solution of the resultant system of balance equations for electron density, and for the translational and vibrational temperature of the gas gives the conditions under which discharge contraction will occur. The results are compared with experimental data for discharge contraction in molecular oxygen, and the limits of applicability of the proposed theory are estimated. The authors thank B. M. Smirnov for supporting the work, and L. M. Biberman for constructive criticism. References 14: 11 Russian, 3 Western.
[101-6610]

USSR UDC 629.78:525.24

THE PARAMETERS OF STABILIZED ELECTRON BEAMS IN THE UPPER ATMOSPHERE

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA - MATEMATIKA-MEKHANIKA-ASTRONOMIYA in Russian No 13, Jul 79 pp 84-86 manuscript received 6 Jul 76

KOLESNIKOV, YE.K., KURYSHEV, A.P. and FILIPPOV, B.V.

[Abstract] The general problem of the injection of a relativistic electron beam into a rarefied plasma where the electron density is much less than the initial density of the electrons in the beam is briefly discussed. The beam is injected along the lines of force of a homogeneous magnetic field (in this case, the geomagnetic field is an additional stabilizing factor). While the question of beam stability is not treated, the theoretical possibility of relativistic beam localization in the upper atmosphere is considered. Based on derived analytical expressions, data are given in tabular form for electron beams with kinetic energies of from 1 to 50 MeV: the average current density in a stabilized beam runs from 0.13 to 160 a/cm^2; beam current for a 10 cm radius; stabilized beam power density ranges from 0.13 to 8,100 MW/cm^2, and the figures are also given for the space charge compensation time and time for the compression of the plasma ion shell, where the latter run from 1,000 to 28 ns respectively. The current level in a stabilized (nonexpanding) beam with a radius of 1 m exceeds 10^6 a for electron energies of more than 22 MeV. Stabilizing factors due to the earth's magnetic field and polarized plasma at different altitudes in the daytime and nighttime atmosphere are analyzed. An expression showing the limitation on the average current density in a stabilized beam is given. References 3: 1 Russian; 2 Western.
[104-8225]

USSR UDC 621.384.6

THE LIU-10 HIGH-POWER ELECTRON ACCELERATOR

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 250 No 5, 1980 pp 1118-1122 manuscript received 9 Oct 79

PAVLOVSKIY, A. I., BOSAMYKIN, V. S., SAVCHENKO, V. A., KLEMENT'YEV, A.P., MORUNOV, K.A., NIKOL'SKIY, V.S., GERASIMOV, A.I., TANANAKIN, V.A., BASMANOV, V.F., ZENKOV, D.N., SELEMIR, V.D. and FEDOTKIN, A.S.

[Abstract] The LIU-10 high-power electron accelerator, first introduced in 1977, represents a new trend in accelerator technology: a linear induction accelerator in which the possibility of varying the acceleration energy with variation in the scale of the accelerating system is combined with the presence of heavy current of a magnitude associated with the direct discharge of low-impedance distributed-parameter lines. The LIU-10 is based on a high-power multielement acceleration system that includes $\sim$400 subnanosecond-precision spark dischargers commuting low-impedance ($\sim$1 ohm) radial lines. The system consists of 14 series-connected modules, each contributing $\sim$1 MeV to the electron acceleration energy. The acceleration of the charged particles can take place either during the first or during the second accelerating-voltage pulse from the inductors. Output parameters: limiting electron energy 13.5 MeV, current-pulse amplitude of electron beam 50 ka; maximum duration of current pulses 20 or 40 ns. Figures 2; references 5 Russian. [119-1386]

USSR

ACCELERATION OF THERMAL NEUTRONS BY ISOMERIC ^{152m}Eu NUCLEI

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31, No 4, 20 Feb 1980 pp 254-257 manuscript received 14 Jan 80

KONDUROV, I. A., KOROTKIKH, YE. M. and PETROV, YU. V., Institute of Nuclear Physics imeni V. P. Konstantinov, Academy of Sciences USSR

[Abstract] When neutrons interact with nuclei in the excited state, inelastic scattering is possible with a noticeable cross section, the excitation energy being transferred to the scattered neutron. For example, calculations for the isomers ^{113m}In and ^{155m}In with lifetimes measured in hours, and also conversion of experimental data on the reverse reaction give a cross section of about 0.1 b in the energy region of $\sim$0.1 MeV for inelastic acceleration. However, the direct reaction of neutron acceleration has not yet been observed experimentally, despite numerous attempts. This paper gives the results of measurements in which acceleration of thermal neutrons was observed

on ^{152m}Eu nuclei. It is found that σ_{in}=0.28±0.06 b at a velocity of 2200 m/s for the thermal neutron flux. It is shown that the forbiddenness of the nuclear transition ^{152m}Eu→^{152g}Eu is insignificant, whereas the γ-transition is slowed by a factor of more than 10^6-10^8 in the (n, n") reaction. The authors thank O. I. Sumbayev for constructive comments, and also G. Ya. Vasil'yev, A. I. Yegorov, Yu. Ye. Loginov, A. M. Nikitin, L. M. Ploshchanskiy, A. I. Shlyakhter, A. F. Shchebetov and reactor personnel for assistance with the work. Figures 2, references 12: 7 Russian, 5 Western.
[127-6610]

USSR

RESONANT RAMAN SCATTERING IN ZnTe AT HIGH EXCITATION LEVELS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 31, No 4, 20 Feb 1980 pp 230-234 manuscript received 14 Jan 80

VALAKH, M. YA. and KORNEYCHUK, V. A., Institute of Semiconductors, Academy of Sciences UkrSSR

[Abstract] In polar semiconductors with high carrier concentration where the plasma frequency w_p is comparable to the longitudinal optical phonon frequency w_{LO}, resonant interaction is observed with the formation of mixed plasmon-phonon modes. When the plasma frequency is low compared with w_{LO}, interaction shows up mainly in broadening of the LO-phonon line. As the carrier concentration increases and w_p approaches w_{LO}, the mixed plasmon-phonon mode shifts toward greater frequencies. This effect has been previously studied in detail for heavily doped semiconductors. The authors consider plasmon-phonon interaction in the nonequilibrium case with resonant two-photon excitation in ZnTe single crystals. When a certain excitation level is reached, the Raman spectrum shows a new band (L_+) that can be attributed to stimulation of a nonequilibrium electron-hole plasma that interacts with LO-phonons to produce bound plasmon-phonon modes. At the same time, there is a sharp rise of intensity of the TO and 2TO lines, and the spectrum of two-phonon transitions 2LO decreases in width, indicating intensification of resonant interaction. Two mechanisms are suggested: 1. a reduction in the width of the forbidden band due to exchange and correlation interaction; 2. intensification of the contribution made by a bound exciton-phonon complex to the process of resonant Raman scattering. Figures 2, references 8: 5 Russian, 3 Western.
[127-6610]

USSR UDC 539.375:678.01

ON THE QUESTION OF THE ACCUMULATION OF DAMAGE IN POLYMERS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA - MATEMATIKA-MEKHANIKA-ASTRONOMIYA in Russian No 13, Jul 79 pp 80-83 manuscript received 23 Mar 78

KASATKIN, K.G.

[Abstract] The accumulation of irreversible microstructural damage in spatially cross-linked polymers is analyzed theoretically for the one-dimensional case of the deformation of a cylindrical rod by compression and tension. Irreversible damage is defined as true residual deformation which does not disappear, no matter how long the load has been removed. The analysis considers the following factors: the behavior of the majority of polymer materials obeys the principle of "decaying memory;" the accumulation of damage is closely related to the phenomenon of creep, where the bulk of microstructural damage occurs during steady-state creep; and there is a critical value of the stress, below which damage does not accumulate. Parameters characterizing the change in the microstructure are proposed, as are simple analytical expressions for the true irreversible deformation related to the damage and for the rate of microstructural damage accumulation. Additional experimental data is needed to further ascertain the properties of the proposed functions and determine the requisite number and structure of the parameters describing the microstructural state. References: 8 Russian.
[104-8225]

USSR UDC 530.145:519.2

THE GROUP EXPANSION METHOD IN QUANTUM KINETIC THEORY

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 24 No 2 1980 pp 140-142
manuscript received 8 Jun 79

KRUGLOV, V. I., Institute of Physics, BSSR Academy of Sciences

[Abstract] A mathematical technique is presented which considerably simplifies derivation of collision integrals of kinetic quantum equations. A previously developed group expansion is used alongside the method of successive elimination of irreducible means in any order of perturbation theory. An appropriate theorem is given which may also be used with the Feynman diagram method, where this theorem will play a role analogous to the Wick theorem in equilibrium statistical mechanics. References 7 Russian.
[100-1015]

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